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Types of Farming in California Analyzed by Enterprises

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Results of a coöperative investigation conducted by the United States Bureau of Agricultural Economics and the California Agricultural Experiment Station

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TYPES OF FARMING IN CALIFORNIA ANALYZED BY ENTERPRISES[1, 2]

L. A. CRAWFORD[3] and EDGAR B. HURD[4]

INTRODUCTION

California agriculture is characterized by great diversity. It includes nearly all the various agricultural types to be found elsewhere in the United States: the dairying of the Great Lakes, the grazing of the Rocky Mountains, the grain farming of the Palouse country of the Northwest, the cotton of the South, the sugar beets of Colorado, the corn of Iowa, and even the rice of Louisiana. Besides the great staples, California is known for its specialty crops: avocados, citrus fruits, dates, deciduous tree fruits and nuts, grapes, artichokes, asparagus, cantaloupes, lettuce, and seeds. Some of these crops are produced commercially nowhere else in the Union; others are produced mainly in California; and many mature and are marketed in seasons when there is little or no competition from other producing areas. More than 200 commercial crops exclusive of livestock and livestock products produced within the state are listed in Appendix A "California Commercial Farm Products." Of these, 70 are important enough to be included in the estimates of acreage and production made by the California Coöperative Crop Reporting Service; 50 or more are reported by the Federal-State Market News Service in daily reports of sales on the terminal markets and in the "Annual Unload Summaries" of Los Angeles and of San Francisco; 38 appear in the annual report on "Carlot Shipments of Fruits and Vegetables by Commodities, States, and Months." Besides the staple and specialty crops, all important types of American domesticated livestock are raised within the state, producing commercially some 45 products.

Though the agriculture of California is greatly diversified, most individual farms are highly specialized. No other large area of the United States shows this tendency more strongly or exhibits so many and varied lines of specialization. This characteristic is partly a heritage from the days of bonanza farming, partly a result of the environmental conditions and types of crops prevailing. As each new enterprise was introduced, high prices generally prevailed for a period, returning exceptionally

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high incomes and thus providing distinct and immediate incentives to specialized production. Because special aptitudes, technical knowledge, and skill are usually required for the successful culture of the specialty crops, producers tend to become best fitted for and interested in one major line of production. The competitive nature of many of the enterprises adaptable to an area, together with the specialized types of equipment often required, inhibits the development of what would be viewed as well-balanced farming programs in many other sections of the country.

Intensive agriculture in the state is relatively young and has only recently passed through the pioneering stages. Almost from the first, farming has been regarded as a commercial pursuit rather than merely as a means of subsistence. It is highly capitalistic in that large amounts of capital and labor are employed in developing and operating farm units. Large capital commitments required for developing new lands, for establishing perennial plantings, and for purchasing specialized equipment tend to perpetuate the original system. These and other conditions have all fostered the development and maintenance of specialized farming in California.

Since 1930 some interest in diversification of individual farms has developed, accentuated perhaps by depressed prices and consequent need for augmenting incomes, particularly on small land holdings. As yet, however, the movement has not been carried far, and specialization still predominates.

Another aspect of California agriculture is its complex pattern. Arable land occurs in discontinuous strips along the coast, separated by intervening hills or mountains, and in valleys surrounded by larger bodies of mountainous lands or desert wastes. Areas markedly similar in physiographic features and in present uses are repeated in widely separated parts of the state. One can drive in less than an hour from intensively farmed areas into dense redwood forests, or one can view from citrus groves the snow-capped peaks of bordering mountain ranges. Occasional dairies or truck farms occur in the midst of extensive orchard or vineyard plantings and isolated blocks of tree fruits or vines are encountered as islands in a sea of grain. To those accustomed to landscapes and types of farming that vary more or less gradually from place to place, such conditions are strange indeed.

PURPOSE AND SCOPE

The three dominant characteristics of California agriculture—its great diversity, its highly specialized farming, and its marked lack of continuity—together with institutional factors and historical develop-

ment combine to form an agricultural pattern of extreme complexity and difficult to interpret. The purpose of this bulletin is to present descriptive material of the natural and economic factors underlying and contributing to the development of this agricultural pattern so as to provide those interested in California agriculture with a general knowledge of the character of agricultural production in different parts of the state.

There is presented first a brief review of the manner in which the underlying natural and economic factors operate in controlling agricultural production. This is followed by an illustrated description of the physiography of California to provide a basis of orientation and understanding of the crop and livestock localization in different parts of the state. The geographic distribution of the various crop and livestock enterprises is depicted graphically by means of dot maps of crop acreages and livestock numbers followed by an explanatory discussion of the factors contributing to the enterprise localizations. Lastly, there is a graphic and descriptive presentation of the localization of various farm types as classified by the United States Bureau of the Census as a result of a special study of the 1930 Census of Agriculture.

Owing to the nature and scope of this study, data from many agencies have been used, especially from the following: the United States Bureau of the Census;[5] the United States Geological Survey; the United States Army Corps of Engineers; the United States Department of Agriculture, in particular, the Forest Service including the California Forest and Range Experiment Station, the Bureau of Agricultural Economics, the Bureau of Chemistry and Soils, and the Weather Bureau; the California State Department of Public Works Division of Water Resources; the California Agricultural Experiment Station; the California Coöperative Crop Reporting Service; and the county agricultural commissioners, extension specialists, irrigation-district officials, county officers, and others familiar with local areas.

Statistical material of the census of agriculture is compiled on the basis of counties and political townships which, in California, are irregular in size and shape and, for the most part, too large to serve as a basis for delimiting the existing localization of the agriculture. It was necessary, therefore, to supplement and localize the census data with information from other sources. In this connection use was made of local crop statistics compiled by the county agricultural commissioners, by irriga-

[5] Although not cited specifically, data on crops and livestock production used throughout this paper have been taken from: United States Bureau of the Census. Fifteenth Census of the United States, 1930. Agriculture. vol. 1–4. 1931–1932.

Also from the monograph: United States Bureau of the Census. Fifteenth Census of the United States. Census of Agriculture. Types of farming in the United States. p. 1–225. 1933.

tion districts, and by the California State Department of Public Works Division of Water Resources.

In portraying the geographic distribution of enterprises and in delimiting the areas within which one or more lines of production predominate, data from these sources were used jointly with the results of field mapping of the agriculture.

In accounting for the types of crops and livestock found in each area, use has been made of published information regarding the environmental adaptation of the various crops and livestock enterprises and of the physiographic conditions of local areas as well as data collected in the field from local informants. No attempt has been made to evaluate the relative advantages of one area over another in producing specific commodities nor to judge the suitability of the types or combinations of enterprises now prevailing. These considerations, together with the delimiting of type-of-farming areas and the analysis of individual farm organizations within each area, necessitate further and more detailed studies preferably on county or area bases.

CONDITIONING FACTORS OF CALIFORNIA AGRICULTURE

Broadly considered, the existing agriculture of developed areas results primarily from the influence of two major groups of factors: the first, physical and biological in nature, includes that large group of factors of which climate, soils, topography, irrigation facilities (in the arid West), plant and animal diseases and pests are important examples; the second, economic and social in character, includes the institutional and economic conditions of markets, transportation, labor, capital, and tenure of operators, the major effects of which, along with those of the first group, are reflected in the relative yields, costs, and returns of the various commodities produced.

The physical, or environmental, factors, both natural and man-made, determine *what may be* produced and, in some measure, *to what advantage*. Because of differences in biological characteristics and habits of growth, each environment provides a setting somewhat more favorable for the production of one crop or type of livestock than for others. Some crops thrive under the cool, humid conditions of a coastal climate; others require or prefer the high temperatures and aridity of interior areas. Certain crops are particularly affected by the texture of the soil; others, by its water-holding capacity; and still others, by the availability of certain plant foods. Each crop possesses characteristic moisture requirements; hence the amount and distribution of rainfall or availability of supplemental irrigation water may be the ultimate determinants of the adaptability of an area for its successful production.

Livestock, likewise, react variously to environment. Each type, and frequently each breed, possesses sufficiently different characteristics to render it more or less adaptable than others to a given set of environmental conditions. Being dependent for support, in whole or in part, upon the crops or natural feeds of an area, the environmental factors exert their influence both directly through their effect upon the animals and indirectly through their effect upon plant growth.

As climatic factors, in general, change more or less gradually from area to area, their influence upon plant growth likewise is only gradual. Soil types, surface characteristics, and irrigation facilities, however, may change abruptly. Hence, while a variety of crops may be grown generally under a given set of climatic conditions, the specific types and their localization will be determined largely by soil and surface differences and possibly by irrigation or drainage conditions.

In addition to limitations imposed by the physical environment, the biological factors of plant and animal diseases and pests may further restrict the production possibilities of an area. Even though most pests are now partially controllable, the net effect of their presence in an area is to lower the competitive position of the affected crop or type of livestock either through reducing yields, lowering the quality of the product, or increasing costs of production.

The second major group, the economic factors, determine which of the products adapted to an area *will be produced* either singly or in combination with others, and to some extent, *in what amount* under the existing institutional and economic conditions.

Within the limits established by environmental conditions, the economic consideration of relative costs and returns are primary factors in influencing choice of farm enterprises. The relative profitableness of the various enterprises adapted to an area is determined by the yields obtained, by the amounts of land, labor, and materials used in producing a unit of the product, and by the prices *received for products and paid for cost goods*. Yields and amounts of the cost factors used in production are materially affected by environment. Prices of products and of the cost factors are influenced by a number of factors—mainly beyond the control of individual farm operators. Institutional and social forces exert their influences, occasionally in a physical sense but mainly through their effect upon price. Legal or other acceptable institutional interferences may prevent the development of an industry. Inadequate labor supplies, lack of available capital or of processing, storage, or transportation facilities for a time may limit production; but, over a longer period, the cost of providing the facility—hence the price charged the farmers—is the ultimate and limiting determinant to its use.

As activities of the individual farmer exert little or no material effect upon conditions of the market, at given prices in central markets, the price he receives for products sold and the price he pays for cost items depend in large measure upon his economic location with respect to the market. In general, as distance from market increases, transportation and handling charges also increase, which brings about a decrease in prices received for farm products and, at the same time, an increase in prices of market goods purchased for production. Thus the lower net returns, as distance from market increases, puts the area, and more particularly specific enterprises, at a disadvantage in relation to production in more favored localities.

As a partial offset to the effects of transportation costs, growers in the more remote areas tend to engage in the more extensive types of agriculture, yielding commodities of low perishability and high unit value in relation to bulk or weight. As the market center is approached the tendency is to shift toward more intensive agriculture and the production of bulkier or more perishable commodities.

Such tendencies are exhibited by California agriculture in general but not in detail. The state is one of a number of areas within the domestic economy with the great centers of population in the eastern and middle-western states as a market. In view of the distance of California from this market, the advantage of producing goods of high unit value and low perishability—or with perishability offset by special handling methods and facilities—is evident. But within the state, the agricultural pattern does not clearly depict zones with respect to economic location. This is due to the counteracting influence of other forces, mainly the dominance of the physical factors in relation to the localization of enterprises.

This is so, because of the wide range of conditions of climate, soil, topography, and other environmental features occurring within relatively short distances and because many of the crops exhibit relatively narrow ranges in adaptation to one or another of the important environmental features. Such crops thrive only under specific conditions of a local environment and because their production cannot be carried on successfully over large areas, they are granted the choice of locations within the adapted area up to the limits of the market demand. In addition, timeliness of maturity has provided some local areas with a distinct price advantage—hence production possibilities—of certain selected enterprises.

Other economic and social factors exert their influence in a number of ways, their force and effect depending upon local circumstance. To trace their individual or combined effects, except as manifested gener-

ally in prices and returns, would involve a detailed analysis by local areas in California, which consideration is beyond the scope of the present study.

The reasons become obvious perhaps when it is pointed out that intensive agriculture in the state is relatively young and has been changing at a rapid rate in response to various stimuli, including such factors as the introduction of new enterprises, extensive irrigation developments, transportation improvements, increasing local population, and shifts in market demand.

The dominance of one stimulus or a group of stimuli has not continued until its full effect has been registered before counteracting forces have set in. Adjustments to existing forces in many instances have not been completed, hence the investigator is hard put to attain a complete and adequate explanation of the existing order. Where one or more economic factors are known to have played a dominant part in shaping the existing agriculture, attention is directed to it in connection with the detailed description of the enterprise or area. In the main, however, physical factors have dominated in shaping the local agricultural pattern.

Since the varied physiography of the state so profoundly influences its agriculture, some idea of the topography, climate, and soils is requisite to an understanding of the prevailing agricultural types.

TOPOGRAPHY

With topographic features in California ranging from the highest point to the lowest in the continental United States, with climates varying from the cool, damp conditions of the north coast to the hot, arid desert area in the southeast quarter, and with a variety of soil types, obviously, one cannot present all the detail, important though it is in differentiating the agriculture of various areas. Presentation of the principal physiographic features, however, will provide a background of information regarding the underlying physical conditions and will serve as a means of orientation to regions and areas.

The topography of the state is simple in its main design—a mountain fringe bordering the coast; another mountain system along the eastern border; between them, enclosed by cross ranges at its northern and southern extremities, the Great Valley; to the west, outside all this, a coastal plain of variable width; and to the east the great area of barren, arid lands belonging partly to the Great Basin and partly to the open-basin regions.

Superimposed on this main design is a highly variable topographic detail (fig. 1). Along the Pacific, in a belt some 20 to 40 miles wide, runs the mass of the Coast Ranges, which consists of numerous indistinct

chains broken down into innumerable ridges, spurs, and short valleys drained by streams of rapid fall. The altitude varies generally from 2,000 to 3,000 feet, with occasional ridges as high as 7,000 feet and peaks extending up to 8,000.

Fig. 1.—Topography of California. (Adapted from: United States Geological Survey. Relief map of United States.)

South of Point Conception, the great headland in Santa Barbara County, the mountains withdraw from the coast, leaving a fairly extensive, fertile, coastal plain of variable width. In this region the mountains are broken by numerous passes at elevations of 2,500 to 3,000 feet and

on their western slopes enclose several sizable valleys of some agricultural importance.

In the eastern part of the state the Cascade Range and the Sierra Nevada form a continuous mountain barrier that isolates most of California from the interior of the United States. Far higher and grander than the Coast Ranges, these mountains are less complicated, particularly the Sierra Nevada, which is essentially one chain of very simple structure. The crest of the range generally exceeds 6,000 feet in elevation, with numerous peaks exceeding 8,000 feet and with Mt. Whitney, the highest point in the United States, reaching 14,501 feet above sea level. Few passes cross the range, and these are all at elevations above 5,000 feet. Precipitous gorges or canyons, mainly the work of rivers, become a more and more marked feature of these mountains as one proceeds northward.

North of Redding in Shasta County, in the vicinity of 40° north latitude, the Cascade Range and the Coast Ranges converge to enclose the northern end of the Great Valley. In joining with a series of cross ranges, they form a belt of very rough country across the northern boundary of the state. The western part of this area is extremely rugged, densely timbered, and excessively wet along the coast. Toward the east the climate becomes progressively more arid, the area more barren, approaching desertlike conditions along the Nevada border. The eastern part consists of precipitous but not lofty ranges and intermountain valleys at elevations of 2,000 to 5,000 feet. Volcanic action has left abundant traces in lava flows, cinder cones, and craters, among which Mt. Shasta is outstanding.

The Sierra Nevada proper extends from Lassen Peak (Shasta County) south to the Tehachapi Pass (Kern County), a distance of about 430 miles. At this latter point the ridge turns westward as the Tehachapi Range to form the southern boundary of the Great Valley. Thus, the Valley is surrounded by a mountain wall broken down only at one point —a gap in the Coast Ranges at the northern end of San Francisco Bay. Through this passes the entire drainage of the Great Valley, the Sacramento River from the north and the San Joaquin River from the south. From the mouth of these two rivers, which unite as they discharge into an arm of San Francisco Bay, to Redding at the northern end of the Valley, the rise is 552 feet in 192 miles; and from the same point southward to Kern Lake, near the southern extremity, the rise is 282 feet in 260 miles. The Valley, in total, is about 450 miles long and, with the lower foothills included, from 25 to 60 miles wide (averaging about 40 miles in width); it contains approximately 18,000 square miles. At the junction of the two rivers is an area, roughly triangular, of about a

half million acres known as the Sacramento—San–Joaquin Delta. This is of special significance agriculturally because of the soil types, water supplies, and climatological conditions.

To the south and east of the Coast Ranges and the Sierra Nevada lies a vast desert region of nearly 50,000 square miles. It is, for the most part, dry and barren, with no drainage outlet to the sea except for small areas along the Colorado River.

The northern part of this territory is made up of Owens Valley, Death Valley, and the Mojave Desert. The limits of the Mojave Desert, though variously defined, are taken generally to include the desert portions of San Bernardino, Los Angeles, and Kern counties and the southern part of Inyo County—an area of about 15,000 square miles.[6] Its surface configuration consists of a series of fairly parallel ridges with intervening desert valleys ranging from about 1,500 to 3,000 feet above sea level and having no drainage outlet to the sea. Flood waters collect in basins or saline lakes within each valley or are carried short distances in stream channels, gradually disappearing in the desert sands.

South of the Mojave Desert and separated from it and from the Colorado River Valley (to the east) by a network of mountains (known in their various parts as the Cottonwood, the Ironwood, and the Chuckawalla) lies the Colorado Desert—a wide valley extending southeasterly from San Gorgonio Pass, in southern Riverside County, to the Gulf of California—a distance of about 200 miles. The area in California drains centrally into the Salton Sea, or Sink, which occupies the lowest part of a large area depressed below sea level. At present the water surface of the Salton Sea stands at about 250 feet below sea level. Though part of the same physiographic feature, the area north of the Sea is known as the Coachella Valley and that to the south, as the Imperial Valley.

CLIMATE

Two important influences on the climate of California are its marine position and its mountains. The great mountain system bordering the eastern side acts as a barrier to the continental type of climate prevailing in the hinterland. To the west of this mountain wall the climate, tempered by ocean influence, is milder and more uniform than at corresponding latitudes to the east. Even though the direct effects of this coastal influence are restricted by the Coast Ranges, the interior areas of the state, except the high mountain territory, have relatively mild winters. Summers are warm but the extreme aridity prevents this heat from being very oppressive.

[6] Thompson, David G. The Mohave Desert region, California. U. S. Geological Survey. Water-supply paper 578:5–7. 1929.

A striking characteristic of the California climate, and one that materially affects its agriculture is the division of the year into two well-defined seasons: cool and damp winters, during which most of the precipitation is received; and warm and dry summers, with practically no precipitation except in the high mountains and in the desert. This phenomenon is largely the result of wind movement and land temperatures. In winter the lower temperatures over the land cool the warm, moisture-laden air from the Pacific Ocean and cause precipitation. The two principal mountain systems play an important part in this action. The updrafts of cold air off the Coast Ranges precipitate only part of the moisture carried by the onshore winds, and this mostly as rain. On the eastern slopes and in the intervening valleys, the rainfall is relatively low, increasing again with altitude as one goes up the western face of the Cascade Range and the Sierra Nevada to about 5,000 feet. Above this altitude much of the precipitation falls as snow, which packs during the winter and, when it melts the following summer, serves as an important source of water for irrigating the interior valleys. During the summer, land temperatures, except in the mountains, are too high to precipitate what moisture is carried by the winds and as a consequence the characteristic warm dry period ensues.

The great length of the state also contributes to the variation in climates within its borders. The northern three quarters lies in the zone of the westerly trade winds, which blow with great regularity, especially in summer, at an average velocity of about 12 miles an hour, carrying their moisture-laden air inland and materially modifying both summer and winter temperatures as far as their force is felt. South of Point Conception (N. Lat. 34° 30′) the state extends into the area of the horse latitudes.[7] Here the westerlies lose their force (an average velocity of 6 miles an hour along the coast) and throughout the summer blow as onshore winds only during the day. In the evening the land air, cooling more rapidly than the air over the ocean, draws down the mountain sides and creates an offshore breeze in opposition to the movement during the day.

These wind differences, together with the normally higher temperatures at lower latitudes, largely explain the lighter precipitation in the southern part of the state as compared with the northern. In addition, ocean, or onshore, winds materially moderate the land temperatures, making them higher in winter in the northern part of the state and lower in summer in the southern part than is usual at the same latitude in continental areas.

[7] "Horse latitudes" are either of two belts, or regions, in the neighborhood of 30° N. and 30° S. latitude, characterized by high pressure, calms, and light, baffling winds.

PRECIPITATION

Figure 2 shows the geographic distribution of the average annual precipitation. The variation is great, ranging from less than 5 inches over a large area in the southeastern quarter of the state to well over 60 inches in parts of the northwestern quarter and in the high mountainous areas. In general, rainfall increases from south to north and from low elevations to high, but with much local variation. Comparison of figure 2 with the topographic map (fig. 1) shows a high correlation between elevation and the amount of precipitation and also indicates the important influence of the mountain ranges upon rainfall. The isohyetal lines on the precipitation map (fig. 2) tend to run north and south paralleling the principal mountain ranges. On the western slopes, precipitation is relatively heavy. On the eastern slope, particularly of the more precipitous Sierra Nevada, it declines rapidly, being lightest on the floors of the intervening valleys. Since most of the farming is in valleys having low elevation, the cultivated areas receive for the most part less than 15 inches of rain, and considerable portions receive less than 10 inches—one important reason why much of the intensive agriculture of California depends upon irrigation.

Other conditions necessitating irrigation for some types of crops are the nature of the seasonal distribution of the rainfall and the marked variation in the total annual precipitation, particularly in areas where the average amount is close to the minimum requirements for crop production. In most areas the variation in total annual precipitation is great —frequently as much as 100 per cent of the average.

In the Colorado Desert and in parts of the Mojave Desert and the southern San Joaquin Valley, the rainfall never suffices for crop production. In other sections where crops are grown, with the exception of the northwest quarter, the precipitation in several years out of fifty (the number varying with the locality) has been inadequate. The proportional number of dry years decreases, however, as one proceeds northward, so that crop failure due to lack of rainfall is a rarity in the northern third of the state. As previously indicated, however, most of the precipitation occurs in winter. In areas of low annual rainfall its limited distribution is therefore a controlling factor in the production of some crops.

Figure 3 shows the monthly distribution of rainfall at each of eighteen selected stations. The seasonal distribution is remarkably uniform throughout the state, except in the desert areas. The greater part of the rainfall occurs from December to March. Most sections get no more than a trace of rain or less in July and August and but little more

in June and September. Thus winter vegetables and fall-sown crops, such as small grains and peas, are best able to utilize the rainfall, whereas spring-sown crops and perennials are generally dependent on irrigation, particularly in areas of relatively low annual precipitation.

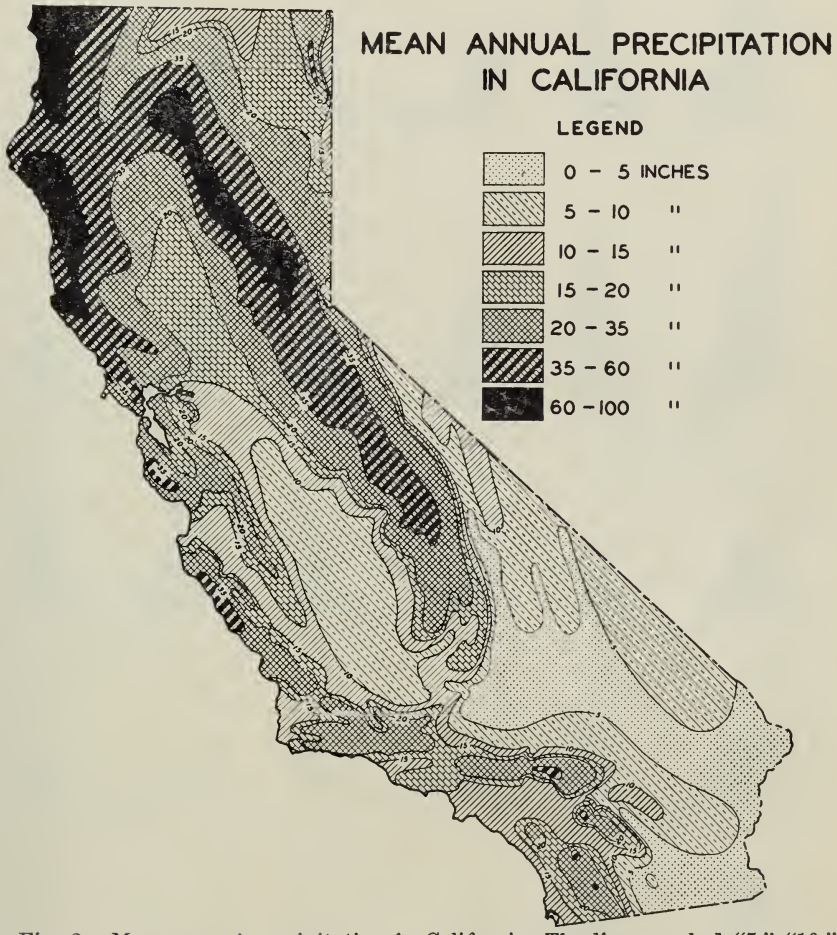

Fig. 2.—Mean annual precipitation in California. The lines marked "5," "10," and so forth connect places having equal mean annual precipitation and are called "isohyetal." (Adapted from map by Burton M. Varney, published in: United States Monthly Weather Review 53(4):156. April, 1925.)

A phenomenon markedly important in its effect upon climate is the summer fog along the coast. This fog belt does not go beyond the crests of the Coast Ranges and extends but a short way up the various valleys that open on the coast. North of Point Conception it persists over relatively long periods as a dense blanket exerting a marked influence upon

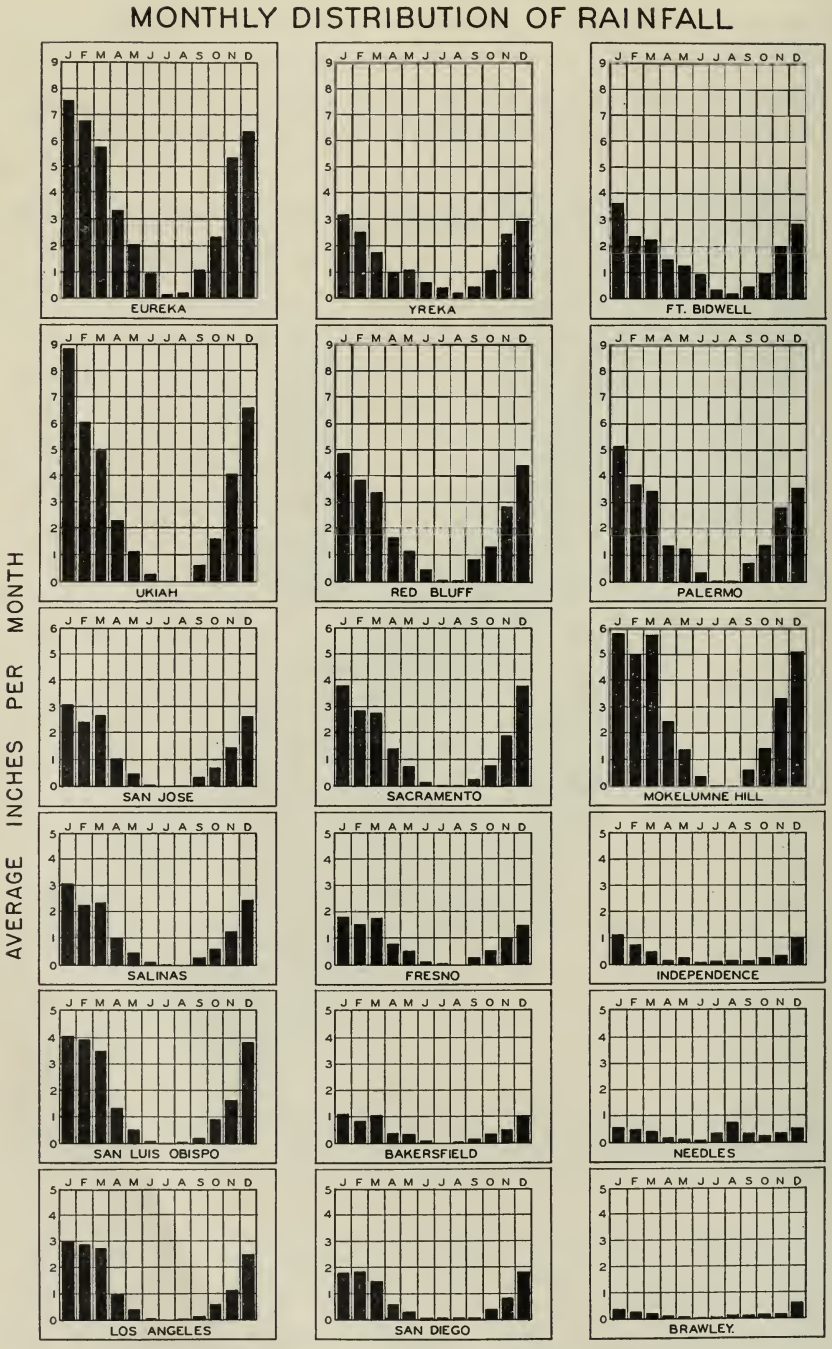

Fig. 3.—Average precipitation by months at eighteen selected stations in California. (Data from: United States Weather Bureau. Summary of climatological data for the United States. Sections 13–16. 1925.)

agriculture by reducing the temperature and increasing the humidity. South of that point, the fog blanket tends to be less dense and more intermittent, so that its effect upon agriculture is much less pronounced.

In the Great Valley, dense land fogs (so-called "tule" fogs) frequently persist in winter for several days at a time. As their occurrence is intermittent and seldom prolonged, they do not materially affect the type of agriculture. In some years, however, the high humidity and lower temperatures occasioned by their presence delay seed germination and plant growth, contribute materially to the development of rust, mildew, and other plant diseases, and thus affect both the quantity and the quality of the winter crops grown in those years.

TEMPERATURE

California owes its pre-eminence as a producer of specialty crops largely to the favorable temperature relations in its agricultural areas —conditions that enable farmers to produce subtropical and temperate-zone crops and also to mature various fruit and truck crops in seasons when they are not produced in quantity elsewhere.

Two temperature relations that markedly affect agriculture are the range in temperatures throughout the year and the length of the growing season. The latter (fig. 4) varies from less than 100 days in the Cascade Range and in the Sierra Nevada to more than 350 days along the coast in the central and southern parts. This variation, about the same as for the entire United States, largely accounts for major differences in the agriculture in different sections. The length of growing season tends to increase from north to south. A much greater variation, however, occurs from east to west in belts paralleling the coast and the mountain ranges. These variations result largely from differences in coastal influence, in wind direction and velocity, in exposure, and in air drainage on the foothill slopes. Along the foothills these belts are so narrow and irregular that they cannot be depicted in figure 4, but they are nevertheless important from an agricultural standpoint.

Summer temperatures are modified materially by the ocean and the mountains, being cooler on the coast and in the hills and warmer in the interior valleys, irrespective of latitudinal position (fig. 5). In fact, the northern Sacramento Valley is warmer in the summer than the northern San Joaquin Valley and nearly as warm as the southern part of the San Joaquin but not for so long a period. These peculiar temperature relations are due to the cool ocean breezes which, entering through the break in the Coast Ranges at the head of San Francisco Bay, fan out over the lower portions of the two valleys and moderate the temperatures.

The length of growing season and the mean summer temperatures are probably the most important variants of temperature affecting crop production. Particularly for specialty crops, however, other temperature relations are important—for example, daily fluctuations in tempera-

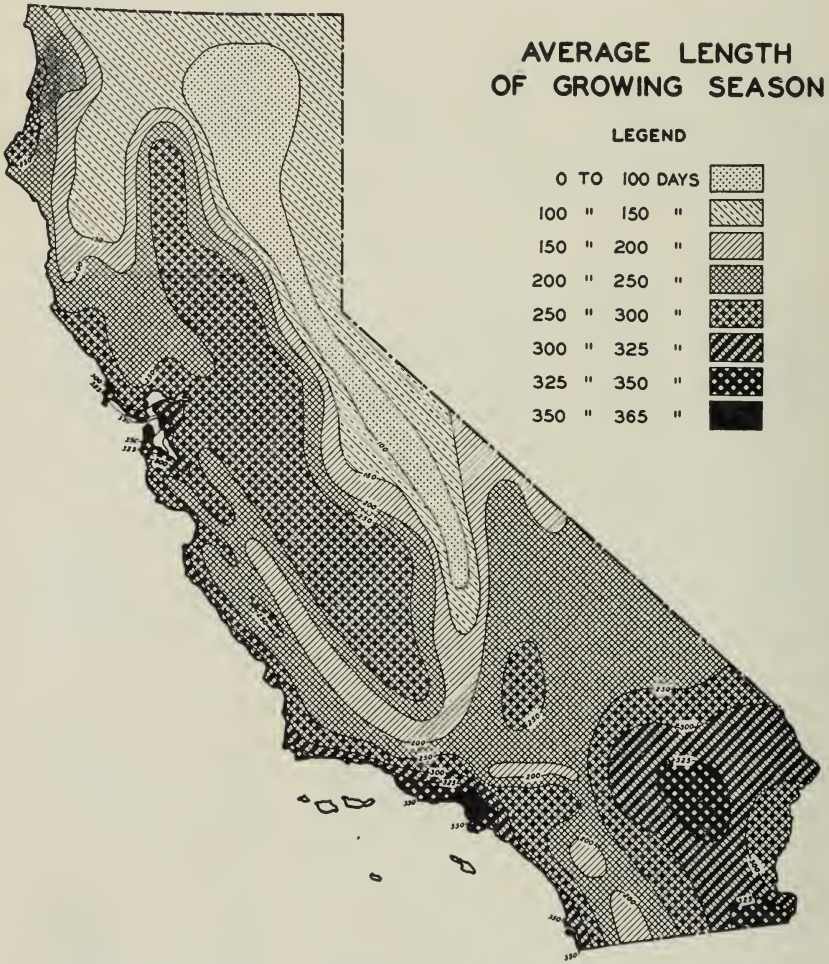

Fig. 4.—Average length of growing season. (Adapted from map published in: United States Weather Bureau. Climatological data. California section. September, 1933.)

ture, frequency and duration of excessive summer heat, or of freezing and below-freezing temperatures. Because of the complexity of these phenomena, not all the important variants can be shown in a series of maps. Figure 6, however, presents the chief measures of temperature in eighteen monthly charts showing the highest and lowest

temperatures recorded and the mean maximum and mean minimum temperatures.

Figure 6 displays two families of temperature curves, those on the

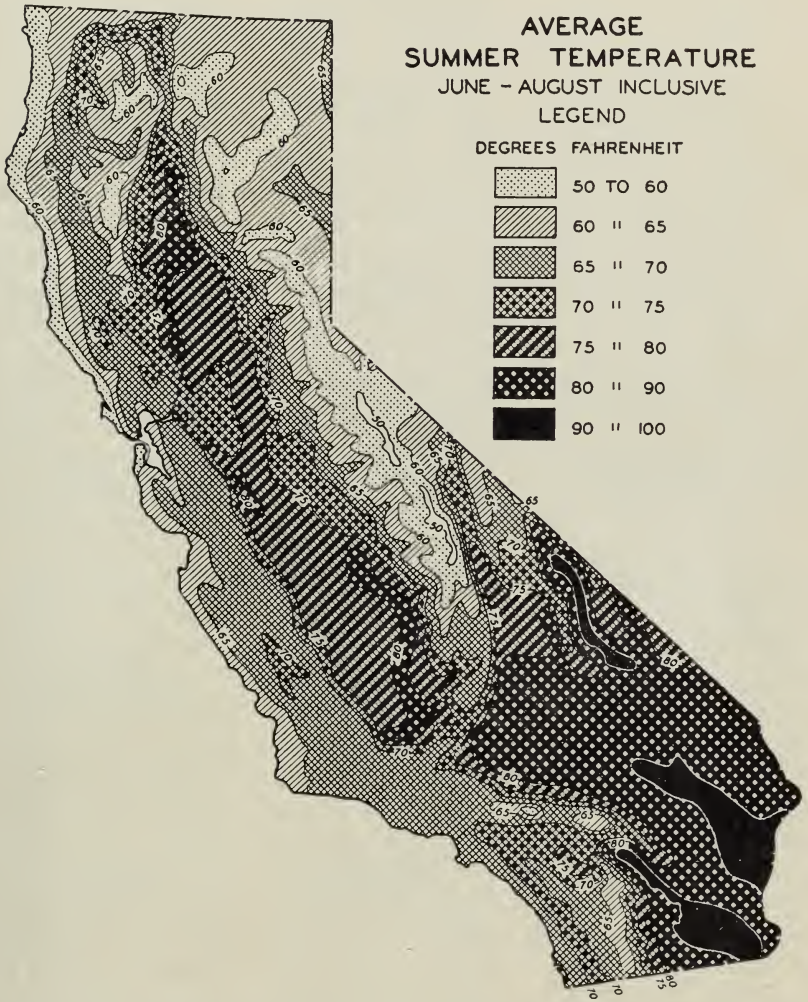

Fig. 5.—Average summer temperatures in California. (Adapted from maps by Joseph B. Kincer, published in: United States Bureau of Agricultural Economics. Atlas of American agriculture. Part II, Section B. Temperature, sunshine, and wind. p. 7. 1928.)

coast being characterized by greater uniformity throughout the year and less fluctuation in daily temperatures than those in the interior. The marine influence, however, is confined to a narrow strip along the coast. Although Ukiah, for example, is in a valley in the Coast Ranges, it has

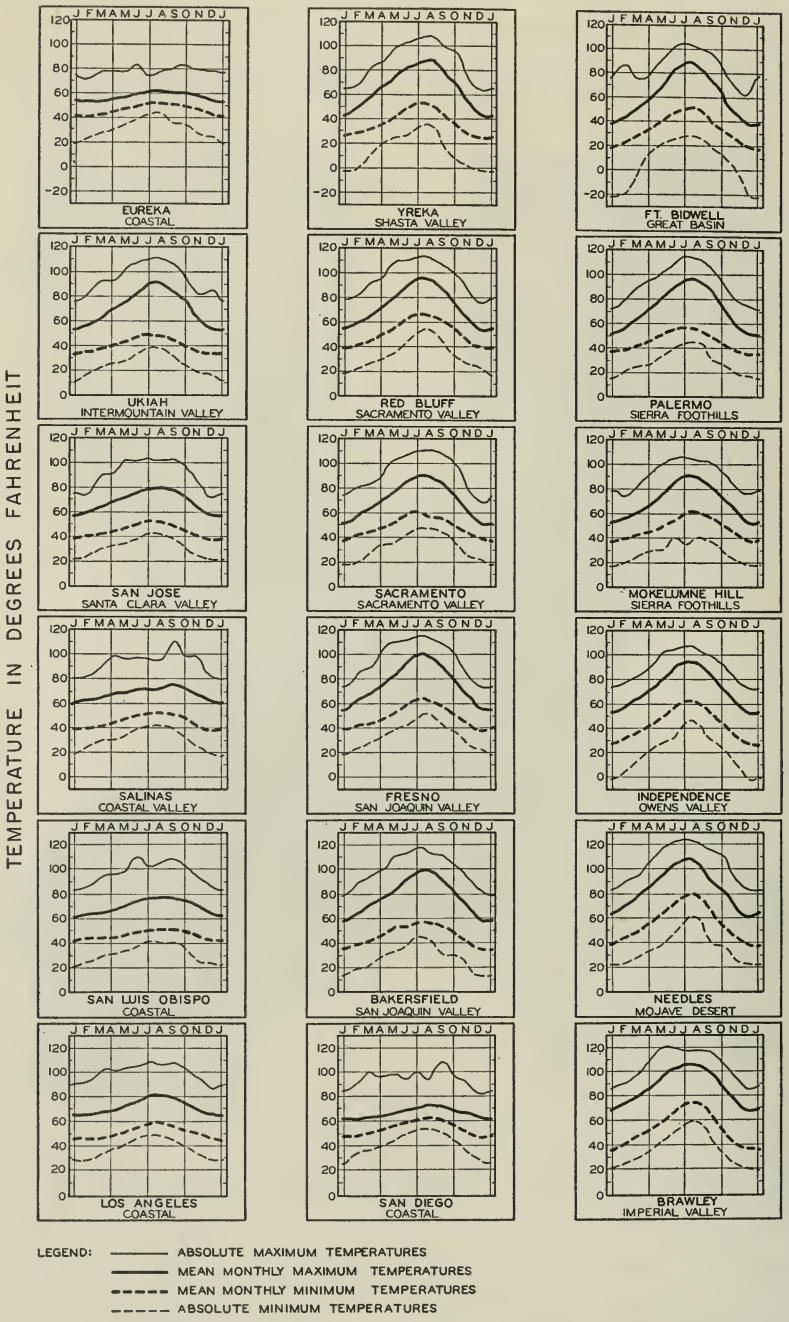

Fig. 6.—Absolute and mean monthly maximum and minimum temperatures (in degrees F) at eighteen selected stations in California. (Data from: United States Weather Bureau. Summary of climatological data for the United States. Sections 13–16. 1925.)

temperature relations similar to stations located farther inland. Both absolute maximum and mean maximum temperatures are reached generally throughout the state in July or August, but there is considerable variation in the length of time that high summer temperatures are maintained. Minimum temperatures occur universally in December and January.

Although freezing temperatures occur in most agricultural areas of the state during the winter, they are usually not severe enough or of long enough duration, except in the mountains, to prevent the growth of hardy plants. Native grass grows throughout the winter along the coast and small grains sown in the fall in the Great Valley are not thrown into a period of dormancy. For less hardy plants, however, the location must be selected with care. Frost hazards vary with minor differences in elevation, exposure, prevailing air currents, and other factors. Thus, marked differences occur in the types of crops grown successfully in given areas. Occasionally some damage to the less hardy plants occurs as a result of unseasonable fall and spring frosts even in areas normally favorable. Deciduous-fruit orchards and citrus groves may, in such instances, be partly protected from frost damage by the use of orchard heaters.

SOILS[8]

The soils of California are exceedingly variable, reflecting the great differences in parent material and climatic environment. The characteristics of most California soils are such that they do not readily conform to the great soil groups of the world. Undoubtedly much of this nonconformity is due to the influence of the periodic rainfall—the winter rainy season and the prolonged summer drought. During the dry season the soils become thoroughly dried out, organic matter is readily oxidized, and the usual effects of a given rainfall and vegetation are not produced. The organic material of the forest floor thus decays rapidly and is thin, loose, and usually dry much of the year. In many areas a real litter cover is almost nonexistent. Even in the redwood area of the north coast, where the high winter rainfall is supplemented by summer fogs, the litter of the forest floor is surprisingly thin.

In California the residual soils of the uplands and mountains are approximately equal in area to the secondary soils from transported materials that occupy most of the valleys and plains. As shown in figure 7, the upland soils of primary origin are most extensive in the Coast Ranges and on the slopes of the Cascade Range, the Sierra Nevada, and

[8] Upon request of the authors, this section on soils was prepared by the late Charles F. Shaw, Professor of Soil Technology and Soil Technologist in the Experiment Station, and by R. E. Storie, Lecturer in Soil Technology and Associate Soil Technologist in the Experiment Station.

other mountains in the northern and eastern parts of the state. Wherever the rainfall is sufficient they bear a good forest cover, but in areas of deficient rainfall they bear brush or grass, according to local conditions.

Fig. 7.—Relief map showing soil associations in California.

Because of their topographic position and the natural covers, the upland soils are utilized mainly for pasturing range livestock and only to a very limited extent for farming.

The valley and terrace soils of secondary origin make up by far the

largest part of the agricultural lands of the state, the most extensive and important being the great interior Sacramento and San Joaquin valleys and the succession of connected valleys in southern California from the seashore inland to Riverside and Redlands. More than half of the desert region of the southeast including the Imperial and Coachella valleys is likewise made up of secondary soils. In addition there are several large coastal valleys, such as the Salinas, Santa Clara, Santa Maria, Russian River, and Lower Eel River. Also throughout all the hilly and mountainous areas there are numerous smaller valleys, some of which are of considerable importance, each filled with material washed from the adjacent uplands. These valleys add materially to the area of the secondary soils available for some form of agricultural use.

The very large number of minor variations that complicate the soil pattern of California cannot be shown on a map of the scale of figure 7, and so they must be grouped under inclusive headings. The soils of the state have therefore been classified into nineteen major soil associations —five including all the upland primary soils, thirteen including the valley and terrace secondary soils, and one of undetermined desert soils. Each of these covers a geographic area that in some cases is fairly uniform but in other cases is more heterogeneous in both relief and soil character.

UPLAND SOILS

The upland soils, formed by residual weathering of parent materials, have been modified by the normal processes of erosion. Usually the profiles are not deep, the hard bedrock ordinarily occurring within 3 or 4 feet. (A profile is a vertical section of the soil from the surface to the underlying unweathered material.) Five upland-soil associations are shown on the map (fig. 7).

1. *Red and Brown Soils Derived in Place from Basic Igneous Rocks (Aiken Association).*—The soils of the Aiken association are derived by residual weathering from andesitic and basaltic lavas[9] and other volcanic rocks. They occupy the mountain slopes and foothills of the northern portion of the lava platform in the counties northeast of Sacramento. The soils vary considerably, according to the character of the parent rocks and the conditions of rainfall. They are generally red to brownish red and are best typified by the Aiken series, which has brownish-red surface soils with bright-red subsoils and is derived mainly from andesitic lavas. They vary from 2 to 6 feet in depth, are moderately acid in reaction in both surface and subsoil, and are shown by analyses to be

[9] The important distinction between andesitic and basaltic lavas, as far as soil characteristics are concerned, is that the former contains bases (calcium, magnesium, and sodium) in amounts from 7 to 15 per cent; the latter, in amounts of 15 to 20 per cent.

definitely lateritic.[10] Clay loams are the prevailing textures, with minor areas of loams and clays and with practically no sandy types. Normally they bear a heavy pine-forest cover, although on the lower slopes they have mixed oaks and pine. In general they have not been cleared, but where farmed they have been used mainly for fruit, particularly pears and apples. They are generally of fair depth and quality.

2. *Brown and Reddish-brown Soils Derived in Place from Lavas and Tuffs (Lassen Association).*—The soils of the Lassen association are derived by residual weathering from a variety of volcanic materials, mainly lavas and tuffs[11] of andesitic and basaltic character. They occupy the lava platform located in the extreme northeastern part of the state. These soils are generally a rich brown, neutral to slightly acid in the surface and frequently have lime in the deeper subsoil. They are normally shallow, rarely exceeding 2 feet to the bedrock, and are dominantly of clay-loam texture. In the profile, stones are common, there being extensive areas of stony clay loam and stony clays. These soils are rarely utilized for agriculture and then only for dry-farmed grain or for pasture. Where deep enough and receiving sufficient rainfall, they carry a forest cover, but over very large areas the cover is brush with scattered pines and juniper.

3. *Red and Brown Soils Derived in Place from Acid Igneous (Granitic) Rocks (Holland-Vista Association).*—These soils are brown, varying from grayish to rich reddish. They are formed by the residual weathering of granitic rocks that vary considerably in composition, being generally rather intermediate in silica content. They occupy mountainous areas at elevations from a few hundred feet to 10,000 feet and more, with corresponding variations in rainfall.

Where the rainfall is above 30 inches, the Sierra and Holland series are most typical. Soils in these series are generally slightly acid in reaction, some showing fairly acid conditions; they are usually deep, and the surface soils are generally medium in texture, with a very high content of coarse angular grit. The subsoils, though often heavier textured than the surface, are readily permeable to roots and water, and most of the upper bedrock is decomposed and somewhat permeable. Usually the soils bear a cover of pines or mixed oaks and pines and are not utilized for agriculture. In Placer County, however, and in a few other foothill locations, selected areas are utilized for growing deciduous fruits and certain other crops.

In the southern part of the state, with less rainfall and lower eleva-

[10] Lateritic soils are high in sesquioxides of iron and aluminum, relatively low in silica, reddish in color, slightly acid in reaction, and friable in structure.

[11] Tuffs are consolidated volcanic ash, generally porous, slaggy, and vesicular.

tion, the soils are somewhat lighter brown, generally neutral in reaction, and are typified by the Fallbrook and Vista series. They bear a general cover of shrubs and brush, with some areas in pine forest; where irrigation is available, they are utilized for olives and for deciduous and citrus fruits. The upland soils of the Holland-Vista association, though not themselves important agriculturally, are the source of the finest valley soils. The material naturally eroded from these uplands produces great areas of valley fill having the highest agricultural quality.

4. *Brown and Light Grayish-Brown Soils Derived in Place from Sedimentary Rocks (Altamont-Kettleman Association).*—This comprises an association of hill and mountain soils generally brown to grayish brown, containing lime in the profile. In the regions of higher rainfall, lime is found in the subsoils only, whereas in the drier sections it occurs in both surface and subsoil. These soils, formed by the residual weathering of sandstone and shale rocks, are usually shallow and often stony. Loams and clay loams are most extensive, with considerable areas of sandy loams and lesser areas of clays. As a rule the subsoils are heavier textured than the surface, and the deeper subsoils contain increasing amounts of bedrock fragments. In the wetter sections the soils bear a natural cover of brush with scattered oak trees; in the drier sections, grass and shrubs. They are most extensively utilized for range pasture, though in a few localities, notably in Contra Costa and San Joaquin counties, considerable areas are dry-farmed to grain under either a two- or three-field fallow system or occasionally in rotation with other non-irrigated crops.

5. *Brown, Grayish-Brown, and Dark-Colored Soils Derived in Place from Sedimentary Rocks (Hugo—Los-Osos Association).*—These soils, which occupy the mountainous to hilly regions of the coastal portions of the Coast Ranges, are derived mainly from sandstones and shales. Predominantly dark brown to yellowish brown, they are closely related to the "brown soil" group of the more humid regions of the world. Their natural cover is a rather open forest of oaks with an undercover of grass, though immediately along the north coast these soils are occupied by dense redwood forests. Throughout the entire profile the soils are acid in reaction—in the coastal fog belt, decidedly so. Loams and clay loams are most extensive, with considerable areas of clays and some sandy loams. The subsoils, though generally much heavier than the surface, are usually penetrated readily by roots and water. When cleared these soils are subject to severe erosion. Practically none of them are cultivated, although a few isolated areas are grain-farmed or planted with grapes. In general, where not occupied by forest or brush cover, they are utilized for range pasture.

VALLEY AND TERRACE SOILS

Secondary soils occupy valleys, terraces, and footslopes bordering the valleys, together with some areas of marine and lacustrine terraces. Formed mainly from material transported and deposited by water, they vary in maturity and character of profile according to the parent material and the period of weathering since their deposition. Most of the California streams, flowing through mountain gorges and canyons, emerge from the canyon mouths to spread over the valley margins, dropping their flood-season load of sediment as great alluvial fans or deltas, while the waters sink into the sedimentary deposit to augment the underground supplies. Where deposition is most continuous and rapid there are large areas of recent alluvial soil with deep, uniform or stratified, but usually pervious, subsoils. Where deposition has ceased or is very slow, the alluvial-soil material has weathered and developed profiles with heavier-textured clayey subsoils, or, where fully matured, with cemented hardpan subsoil horizons. In a few areas, wind movement has modified the surface soils and, even more rarely, influenced the entire profiles. Almost always, however, the accumulation of soil material has been dominated by water and shows the characteristics of alluvial, lacustrine, or marine deposition.[12] Thirteen associations of these soils are shown on the map (fig. 8).

6. *Brown Alluvial Soils from Granitic Material* (*Hanford-Hesperia Association*).—Soils in the Hanford-Hesperia association include the recent to moderately developed soils from granitic alluvium. The soils are generally deep, pervious to roots and water; some shade of brown; neutral to slightly basic; with high fertility, favorable profile characteristics, and a surface configuration well suited for irrigation. Although sandy loams are most extensive, nearly all light and medium textures occur. Whereas younger members are deep deposits of recent alluvium without much profile differentiation, the older series approach claypans in character. As a rule the entire profile contains noticeable quantities of angular grit or coarse sand. In the San Joaquin Valley the soils occupy a series of very irregular deltas or gently sloping alluvial fans lying between the hardpan lands on the upper side and the trough soils on the lower margin. They constitute the most productive soils of the Great Valley, where they cover nearly two million acres and produce a vast array of field, fruit, truck, and forage crops. In southern California they occupy the steep to gently sloping fans that constitute the broad alluvial footslopes at the base of the mountains. They make up the major portion

[12] Alluvial deposition is deposited by flowing water; lacustrine deposition, by lake action or accumulation in a lake bed; marine deposition is deposited or modified by action of the sea.

of the country from the ocean east to the San Bernardino mountains and also most of the valley uplands in Riverside County. In the southern section they are devoted to a wide variety of crops, of which the most conspicuous are the citrus fruits on the upper slopes where frosts are rare or not severe. The lower portions of the alluvial fans where the textures are heaviest are occupied by truck and field crops, while the intermediate slopes are usually sandy loams, planted to grapes or deciduous fruits.

7. *Red and Brown Hardpan Soils (San–Joaquin—Redding Association).*—These soils have developed (as a typical feature of the profile) a dense, rocklike hardpan subsoil horizon. They are red to brownish red in both surface and subsoil, and have been derived from deposits of ancient sediments that have been lifted above later deposition and weathered for a very long period. The San Joaquin series and its relatives, derived almost wholly from granitic rock, constitute the undulating to rolling plains on the east side of the San Joaquin and Sacramento valleys, together with a few small isolated bodies in southern California, not shown on the map. The depth of the soil and subsoil above the hardpan will average about 2 feet, with normal ranges in depth of from 18 inches to 3 feet. The surface soils are usually sandy loams or gritty loams, and the upper subsoils are clay loams or clays. They are usually slightly acid in reaction and show a somewhat lateritic trend of weathering. Even under the best conditions of irrigation and climate, these soils are inferior in quality. They are used primarily for range pasture and dry-farmed grain, although in some regions, where irrigation water is wisely managed, they bear vineyards and some deciduous and citrus orchards.

The Redding series and its relatives are derived mainly from granitic rock, with a considerable mixture of material from lavas and from sandstones. Representing a deposit older than that which formed the San Joaquin—one made up of great masses of cobbles and gravels—they are typically developed in the northern Sacramento Valley and on the terrace remnants opposite the mouths of most of the large streams flowing from the Sierra Nevada. The soils are brownish red, highly acid in reaction, with bright-red acidic subsoils resting at depths of 2 to 4 feet on a hard-cemented hardpan. This in turn rests on the mass of cobbles and gravels, which themselves are often partially cemented. Gravelly loams and gravelly sandy loams are the dominant surface textures, with gravelly or cobbly clay subsoils above the hardpans. Although the soils show definite lateritic characteristics, they are not laterites. They are generally in dry-farmed grain or pasture, but, because of favorable temperatures, limited areas are devoted to deciduous and citrus fruits. The orange districts near Oroville and east of Sacramento are located primarily on

the Redding soils, as is likewise the fruit district in southern Shasta County. The natural cover of the San–Joaquin—Redding association is grass with occasional areas in brush or scattered oaks. They constitute the extensive areas of the so-called "red hardpan lands" of California.

8. *Gray Alkali Soils of the Great Valley (Fresno–Pond Association).*—These soils, occupying the lower and flatter portions of the San Joaquin Valley plain, are derived primarily from granitic materials essentially the same as those that formed the Hanford-Hesperia and San–Joaquin—Redding associations. Since, however, the materials have accumulated under conditions of poor drainage, the characteristics have been determined largely by these periodically wet conditions. The soils are usually calcareous throughout the profile, and the major portion of the entire basin area shows relatively high accumulations of alkali. In general the profiles have heavy clay subsoils and often lime hardpans. The soils tend to be gray or brownish gray, of sandy loam to silty clay-loam texture. Mainly because of the alkali, the quality of these soils is relatively low and they are utilized primarily for pasture.

9. *Dark-colored San Joaquin Valley Trough Soils (Merced Association).*—Soils in the Merced association occupy the trough of the San Joaquin Valley. Materials have accumulated under conditions of poor drainage, with dark-gray clays or clay loams that appear black when wet. The profiles generally have moderately dense clay subsoils with a high accumulation of lime in the lower subsoils. The organic matter of these soils is generally high as compared with other California soils. The alkali content is variable. Soils free of alkali or containing slight concentrations can be used for cotton, grains, and other field crops, whereas those more poorly drained and containing the higher alkali concentrations are utilized primarily for pasture.

10. *Brown Alluvial Soils from Basic Igneous Material (Vina–Modoc Association).*—The soils of the Vina–Modoc association are decidedly variable, including areas of extensive alluvial-fan deposits and lacustrine sediments that fill some of the larger valleys, and miscellaneous fan and flood-plain materials in the smaller valleys. The soils are derived from the andesitic lavas of the adjacent uplands and are generally fine-textured. In the northern portion of the Sacramento Valley, the Vina series and its relatives constitute an area of recent and young alluvial soils of high quality. They are chocolate brown, deep, pervious, and neutral in reaction. In the somewhat more mature profiles they contain lime in the subsoil. Surface textures vary from sandy loams to clays, with subsoils about the same or slightly heavier. The soils are used for deciduous fruits, nuts, alfalfa, and other field crops.

In the Shasta Valley (Siskiyou County), some of the soils are rela-

tively shallow, are pervious, and have sandy loam, gravelly loam, or loam textures throughout the profile. There are large areas of older soils, usually with loam to clay-loam surface horizons, and heavier-textured subsoils with accumulations of lime and occasionally lime hardpan horizons. In the valley areas of the lava platform in the northeastern counties, the soils are generally rather shallow, resting on a dense, compact substratum at depths of less than 3 feet.

In the Honey Lake Valley and in numerous small valleys throughout the northeastern region, the soils vary materially, ranging from deep, high-quality soils similar to the Vina, to the broad, flat, alkali soils of the old lake basin, these latter being generally clay loams or clays with compact clay subsoils. Because of the limitations imposed by a very short growing season, the agricultural possibilities are decidedly limited; these areas are used mainly for pasturing stock and for producing hay for winter feeding.

11. *Brown and Light-brown Alluvial Soils from Sedimentary Material (Yolo–Sorrento Association).*—These soils, derived from sandstones and shales, vary with the differences in parent material and also with the age or stage of weathering. They occupy gently sloping alluvial fans and flood plains, and terrace remnants of older plains. Shades of brown predominate in the soils; and they are neutral or basic in reaction, tending to develop lime accumulations in the subsoil. Especially is this true in the older and more mature profiles. The younger soils are deep and pervious, with moderate to good drainage; the more mature soils have accumulations of clay in the subsoil, which, in the fully mature profiles, develop to a dense claypan horizon. Surface-soil textures, though varying widely, are predominantly clay loams and loams. The mature soils have sluggish drainage and restricted root penetration; the younger soils, usually good drainage and free penetration by roots and water. These soils are most extensively developed on the lower west sides of the Sacramento and San Joaquin valleys, and in Ventura and Contra Costa counties. The younger members are highly productive, comparing favorably with those of the Hanford-Hesperia association, and are utilized for a wide range of crops including citrus in the south, deciduous fruits in the north, and alfalfa, grains, and truck crops throughout. The quality of the older members is markedly reduced by the presence of the heavy clay subsoils and they are utilized mainly for field crops and pasture.

12. *Light-colored Alluvial Soils from Calcareous Sedimentary Material (Panoche—Lost-Hills Association).*—These soils, occurring mainly on the west side of southern San Joaquin Valley, are derived mainly from sandstones and shales and occupy sloping alluvial fans and flood

plains in regions of low rainfall. The soils are generally calcareous throughout the profile and are dominantly light grayish brown. The profiles are youthful to semimature and usually pervious, though some of the older soils have rather dense clay subsoils. Considerable areas, possibly one third of the total, have injurious accumulations of alkali salts; but most of the valley slopes being free of alkali, with sandy loam or loam surface soils and pervious subsoils, constitute an area of good-quality soils. Because of the aridity of the west side of the southern San Joaquin Valley and on the Carrizo Plains in San Luis Obispo County, and the limited supplies of irrigation water, these soils are used primarily for range pasture, with some dry-farmed grain grown in those sections where local rainfall suffices. Under irrigation the soils would be productive, but at present there appears to be an inadequate water supply.

13. *Grayish-brown Alluvial Soils from Mixed Material (Salinas–Metz Association).*—These soils, derived from mixed rocks but mainly sandstone and shales, occupy flood plains in the coastal valleys—chiefly the Salinas, Santa Maria, Santa Ynez, and the southern part of the Santa Clara Valley. The soils are variable in color and lime content; the more recently deposited soils are light brown, uniformly calcareous throughout the profile, whereas, the slightly older soils generally are dull grayish brown or brownish gray and with lime accumulated only in the subsoil. There is relatively little alkali, and though the soils have a wide range of texture, most of them are moderately pervious, with good water-holding capacity. Wherever, in these valleys, sufficient irrigation water is available, excellent crops of alfalfa, beets, seeds, and vegetables are produced. Under dry farming, beans and grains predominate, with smaller areas devoted to pasturage.

14. *Brown to Dark-colored Coastal-Valley Alluvial Soils (Ferndale–Bale Association).*—These soils occupy the valleys of the Coast Ranges. Although mainly derived from sandstone and shales, they vary materially in origin and character. This association includes many series, but few are of much extent. The recent alluvial soils are deep and pervious and locally prominent. The moderately old soils having heavy but permeable subsoils, together with considerable areas of soils having dense clay subsoils, are more extensive and occupy the major part of the valleys in which they occur. In general these soils are noncalcareous and acid in reaction throughout the profile. Surface textures, though varied, tend to be moderately heavy. In most localities, either because of topographic position or because of the heavy subsoils, the land has sluggish drainage, so that crops may suffer from excessive moisture in the rainy season. A variety of crops is grown. In the Eel River Valley, the soils

consist mainly of deep, recent or young alluvial deposits of good quality and are used almost wholly for forage and root crops in conjunction with dairying. In the Russian River valleys and in Napa, Solano, Lake, and Santa Clara counties, where the older soils with heavy subsoils are more extensive, they are of fair to good quality and are utilized to a considerable extent for deciduous fruits and grapes. The utilization of the soils in this association is determined in part by their character, but mainly by the local climatic conditions, and the accessibility of receptive markets.

15. *Variable-colored Claypan Coastal-Terrace Soils (McClusky–Olivenhain Association).*—These soils, which occupy limited coastal areas from San Diego northward to Santa Cruz, are of mixed geological origin and occur on terraces, usually of marine formation. Though decidedly variable, they are generally brownish, with heavy-textured subsoils. Surface textures vary widely, sandy loams and loams predominating. The soils are noncalcareous and normally acid. They are only of fair productive capacity but, because of the very favorable climatic conditions, some of them give good yields of selected crops. Under irrigation some avocados are grown on the more favorable areas, together with small fruits and vegetables. Under dry-farming conditions, lima beans and grain hay predominate.

16. *Dark-colored, Poorly Drained Basin Soils (Stockton–Sacramento Association).*—In the Stockton–Sacramento association have been placed the soils of the enclosed basin of the Sacramento Valley and those bordering the Sacramento—San–Joaquin Delta. These uniformly heavy-textured soils, generally clays with some areas of clay loams, are all derived from fine-textured sediments of mixed geological origin that have settled in these basins from slow-flowing muddy water. Generally they are neutral to slightly acid but show accumulations of lime in the deepest subsoil horizons. Whereas in their natural condition they were flooded for several months each year, they are now protected by levees and are drained by canals and pumping plants. Subdrainage is generally rather sluggish. Along the margins of most basins, alkali has accumulated; and there are also extensive, affected areas in some of the basin bottoms. The basin soils are suited only to the shallower, fibrous-rooted types of crops; all attempts to establish fruit orchards or vineyards on any of them have failed. The most characteristic series are the Stockton, Sacramento, and Willows soils. The Stockton has black clay surface soils with grayish calcareous clay subsoils resting on a dense impervious substratum at depths of about 3 feet; they are utilized mainly for rice in Butte County and for grains elsewhere. The Sacramento has dark-gray silty clay or clay soils containing considerable organic matter, with deep

clay subsoils that are often mildly calcareous and frequently contain gypsum; they are planted most extensively with grains, sugar beets, and other annual field crops. The Willows series, reddish brown, with heavy clay textures in surface soils and subsoils, are very dense and slowly pervious to water. Originally called "goose lands," they are far less productive than the other two series, partly because of the dense structure and partly because of extensive areas containing injurious accumulations of alkali. Where farmed, they are now being utilized for rice.

17. *Dark-colored, Highly Organic Soils (Ryde–Roberts–Peat-Muck Association).*—In the delta of the Sacramento and San Joaquin rivers is an area of about 250,000 acres of organic soils derived from peats. These are composed of the accumulation of partially decayed tule (*Scirpus acutus*) and other sedges. They are highly organic, usually with only 10 to 30 per cent mineral matter. The surface soils, where decomposition is most active, are of finer texture and contain more mineral matter, whereas the subsoils are usually very fibrous, with much coarse organic matter. They are moderately acid, though some areas may contain excessive amounts of salts. Their water-holding capacity is high, but the soils are very pervious. In their natural condition they were submerged during much of the year, but now they are protected by levees and drained by pumping the water from ditches and canals over the levees and into the sloughs and tidal channels. They are slowly subsiding because of compaction, the normal oxidation of their organic material, and unwise burning. Since, at present, almost all the farmed peat lands lie below sea level, the provision of adequate drainage is becoming increasingly difficult. These soils are highly productive and for the most part are intensively farmed. The principal crops are asparagus and other truck crops, beans, corn (maize), onions, potatoes, sugar beets, and grains.

18. *Light-colored Alluvial, Semilacustrine, and Wind-Modified Desert Soils (Imperial–Coachella Association).*—The Imperial Valley and the Palo Verde, Yuma, and other small valleys along the Colorado River are made up of sediments derived mainly from sandstones and shale rocks, transported by that river and deposited either as alluvial flood plains or as semilacustrine sediments. Although varied in texture, they are mainly silts and clays, calcareous throughout, with large areas containing high accumulations of alkali. The subsoils of the Imperial and Meloland series and the deeper substrata of the Holtville and Rositas series are dense, slowly pervious clays. Because of the heavy texture of this deeper material, drainage is generally sluggish. Without irrigation the soils support only a scant growth of desert vegetation, but with water available they serve for a wide variety of crops. Yields are fair to excel-

lent, largely according to the texture and the freedom from concentrations of alkali. The Coachella Valley soils differ materially, being made up of granitic sediments carried in from the surrounding mountains and deposited as broad alluvial fans and sloping flood plains. They are composed mainly of the coarser-textured sands and sandy loams that have been somewhat wind-modified. In their natural state these soils are deserts, but under irrigation they produce good yields of winter vegetables, early table grapes, dates, citrus fruits, and some alfalfa.

DESERT VALLEY AND UPLAND SOILS, UNDETERMINED

19. *Undetermined Desert Soils.*—The soils of the desert region are distinctive. More than half the total area is made up of secondary soils, with the emergent rocks and mountain peaks almost buried in their own debris and with little or no actual residual-soil accumulation. The hard rocks that normally would be the site of residual soils are eroded entirely bare, and the upper portion of the long footslopes is usually a rock pediment covered thinly with stones and gravel. Below the pediment, as a continuation of the same slope, is the beginning of the secondary material washed down from the rock masses by the occasional torrential rains. The upper portions are coarse and gravelly; the broad intermediate slopes are usually sandy, grading into the flat or basinlike enclosed sinks of heavy-textured soil material.

The intermediate slopes of sandy loam are usually potentially good soils. The material above them is too coarse and stony for economic use, and the heavy soils of the basins and sinks are strongly charged with alkali salts. In general, agriculture is impossible in this region because of lack of water. Local supplies are usually saline, coming mainly from the basins where the salts have accumulated. Occasionally, limited supplies for irrigation can be obtained on the lower portion of the slopes where good soils are available. Under these conditions, as in the Antelope Valley in northeastern Los Angeles County, the narrow belt along the Mojave River (Piute Wash) in San Bernardino County, and very limited areas elsewhere throughout the desert, agriculture has been established.

MAJOR LAND USE

The agricultural land use and natural cover of the state are shown in their broader aspects in plate 1. This map, a composite of information from numerous sources, shows the major types of vegetative cover, classified as brush, desert, grass, and timber, together with the arable lands irrigated and dry-farmed at the present time. It provides a visual impression of the relative importance and the geographic location of the

farming areas in relation to the range territory and also indicates the relative importance of irrigation in various sections.

As indicated on pages 12 to 21, there is a gradation in climate from the hot, arid desert in the southeastern part of the state to the cool, humid climate and heavy rainfall of the north coast. Also there occurs, generally, an increase in rainfall and a decrease in temperature from low elevations to high. Corresponding to these changes in climatic conditions, the natural vegetation varies from desert cover to grass or brush and finally to timber. Cultivated areas are found mainly on the valley floors, on benches bordering the valleys, and along the coast. Limited areas of rolling hill lands and discontinuous tracts interspersed throughout the range territory are also regularly or occasionally cultivated.

California land area totals about 100 million acres. The approximate area[13] of each major type of vegetative cover, the cultivated land—irrigated and nonirrigated—and the utilization of the remainder of the land area are given below. See also tables 2 and 3 (p. 127, 128).

Land uses and natural cover	Millions of acres
Cropland, dry-farmed	4.9
Cropland, irrigated	3.5
Pasture, irrigated	1.2
Miscellaneous farm lands	1.5
Total agricultural lands	11.1
Grazing lands (grass, woodland-grass, and sagebrush in Great Basin area used for grazing)	25.2
Brush fields (brush and dense woodland areas)	13.9
Desert and sagebrush	21.7
Forest (mature timber, second growth, and restocking)	16.7
Noncommercial timber and barren lands	3.7
Special reserves (parks, primitive areas)	3.1
Urban and unclassified	4.2
Total area of state	99.6

Brush fields and forested areas, comprising about 30.6 million acres, are prominent in the coast region, in the northern mountain counties, and in the Sierra Nevada. Timber predominates in the north and in the mountains at intermediate elevations. Proceeding southward and from high to low elevations, one finds timber gradually displaced by woodland or brush. Along the crests of the Sierra Nevada and the highest ranges

[13] Compiled by authors from data presented in: United States Forest Service Report to National Resources Board for State of California. 1934.
United States Bureau of the Census. Fifteenth Census of the United States, 1930. Agriculture. vol. 1:58. 1931.
United States Bureau of the Census. Fifteenth Census of the United States, 1930. Irrigation of agricultural lands. p. 86, 327. 1932.

in the north there are areas, alpine and subalpine in character, totaling about 3.7 million acres. These, being too cold or too precipitous and rocky to support commercial timber, are useful mainly as recreational areas for summer camping and for winter sports.

The great desert in the southeastern quarter of the state occupies approximately 21.7 million acres. Parts have been reclaimed for farming by the development of irrigation. After winters of at least normal precipitation, the northern part of the desert affords a little early-spring grazing. In general, however, and with these exceptions, the sparse vegetation and the scarcity of water render this vast territory valueless for agricultural purposes.

The grazing lands, approximately 25.2 million acres, include areas dominantly in grass, open woodland with grass undercover, and the sagebrush country in the northeast corner of the state. On these lands, livestock are grazed during all or parts of each year according to local conditions. The greatest area of grasslands occurs on the foothill slopes bordering the Great Valley and in the Coast Ranges in the central part of the state.

Besides the grazing lands, the brush, desert, and forested areas are utilized to some extent as range for livestock. About 19.6 million acres of the brush, timber, and woodland-grass areas are within the national forests. Approximately 10.5 million acres of these lands are grazed during parts of each year by some 150,000 head of cattle and horses and more than 300,000 head of sheep and goats (table 1). These lands constitute a controlled reserve where the number of livestock and the time of grazing are restricted in order not to impair the undercover and tree growth. These and other restrictions are designed to preserve the timber, to prevent soil erosion, and to protect sources of water supply.

On only about 9.5 per cent of the land area of the state has the natural vegetation been displaced by cultivated crops and irrigated pastures. These farmed lands are confined largely to the valley floors and bordering footslopes in the former desert and grass areas. Less extensive acreages occur on the benchlands and rolling hills bordering the coast and in the mountain valleys, some of which are too small to appear in plate 1. The utilization of these lands for cropping in the desert and in much of the grass areas has been made possible by irrigation, without which crops would be uncertain or would fail. In areas where the normal precipitation suffices for some crops, irrigation extends the range of adaptability and widens the possibility of crop selection, and in virtually all areas it markedly improves the yield. The increasing dependence upon irrigation for crop production in the warmer and drier sections is shown in plate 1.

Superimposed on this setting and overlapping many of the land classes listed on page 34 are the mineral, oil, and timber resources, the game refuges, the primitive areas and recreational zones that occupy a significant position in land use without affecting materially the agricultural use over large areas. No consideration, therefore, will be given to these forms of land use except to point out their effect in shaping the prevailing agriculture in a few local areas.

TABLE 1

NUMBER OF STOCK GRAZED, PERMITS ISSUED, AND NET AREA OF NATIONAL FORESTS IN CALIFORNIA, 1929–1938

Year	Stock grazed		Permits issued		Net area of national forests in California region*	
	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	In federal ownership	Usable and open to grazing
	number	*number*	*number*	*number*	*acres*	*acres*
1929	155,663	423,666	1,825	362	19,199,639	†
1930	154,621	417,077	1,875	366	19,216,332	10,524,710
1931	151,620	406,896	1,838	333	19,257,432	10,443,878
1932	153,080	388,783	1,816	327	19,258,676	10,370,543
1933	142,736	370,153	1,756	358	19,173,012	10,303,686
1934	148,859	360,202	1,644	294	19,175,640	10,265,145
1935	143,815	323,753	1,564	249	19,341,017	10,249,884
1936	143,827	310,360	1,609	241	19,382,518	10,262,129
1937	140,446	331,922	1,501	233	19,458,636	10,336,443
1938	132,976	302,984	1,441	205	19,588,767	10,462,182

* The California region varies in area. In 1937, for example, it encompassed a gross area of 24,281,674 acres of land within the boundaries of the national forests. This area included approximately 610,000 acres in adjoining states (mainly Nevada) and 445,000 acres in California supervised by the Pacific Northwest region. The gross area of national forests in California was 24,113,217 acres. In view of the slight difference in acreage (less than 1 per cent), it is held that data for the state of California would not vary significantly from those reported for the California region.

† Data not available.

Source of data:

By correspondence from United States Forest Service. California Region (region 5).

The nature and conditions of utilization of the range and of the farming areas will be shown in some detail through graphic and descriptive presentations of (1) the geographic distribution of the important crop and livestock enterprises; and (2) the distribution and nature of the major types of farms, as defined by the 1930 Census of Agriculture.

PHYSIOGRAPHIC REGIONS

As shown by the topographic, soil, and land-use map (plate 1), arable lands in California occur mainly on the seaward slopes of the Coast Ranges and in the various valleys, including their bordering foothills with deserts, hills, or high mountains separating one crop area from another. These natural barriers divide the state into rather broadly

defined physiographic regions that exhibit differences in the major aspects of climate, topography, and, to some extent, soil conditions. The four major regions are the coast, the Great Valley, the desert, and the mountains, within each of which, however, there is still a wide range

Fig. 8.—Physiographic regions of California.

of physical conditions, particularly differences in soil, in climate, and in irrigation facilities. Because of such differences, these regions may be subdivided further, according to the fineness of definition of each of the factors. For present purposes the state has been cut into seven physiographic regions that will serve as a basis of orientation to the local areas to which reference is made. These regions—the north coast, the

central coast, the south coast, the Sacramento Valley, the San Joaquin Valley, the desert, and the mountains—are depicted roughly in figure 8.

The boundaries of these regions were made to coincide, as far as possible, with county lines in order to facilitate the use of census data by counties.[14] In some instances it was necessary to deviate from this procedure, particularly where marked breaks in physiographic features traversed, or did not occur in proximity to, county lines.

The eastern limits of the coastal regions were established by roughly following the 150-day growing-season line (fig. 4) from the Oregon border to the northeast corner of Mendocino County, thence south to the Tehachapi Mountains along the county lines, which in general follow the crest of the most easterly ridge of the Coast Ranges. From this point to Mexico the line roughly corresponds to the 10-inch-rainfall line.

The physical differences between the three coastal regions are those of degree rather than kind. As previously described, climatic conditions along the coast change more or less regularly and gradually from north to south, the rainfall decreasing and mean temperatures increasing for equal topographic positions. The boundaries of the regions are therefore somewhat arbitrarily established. There are three sets of topographic conditions in all three regions: mountains, interior valleys, and coastal plains. The proportion of the area in mountains, however, is greatest in the north-coast, least in the south-coast, and intermediate between the two, in the central-coast region.

The mountain region embraces the territory occupied by the Cascade Range, the Klamath Mountains, the Sierra Nevada, and that portion of the Great Basin which extends into the northeastern corner of California. The division between this region and the Great Valley is established at the lower limits of the mountain ranges approximately where their more precipitous slopes break into the rolling foothills or the valley plain.

The valley region, therefore, occupies the lower foothills and plains of the territory drained by the Sacramento and San Joaquin rivers and their tributaries.

The desert region occupies that vast territory in the southeastern quarter of the state which lies to the east of the Sierra Nevada and the Coast Ranges. It comprises three distinctive physiographic features: the Colorado and the Mojave deserts, which have no drainage outlet to the sea, and the Colorado River drainage area bordering the eastern boundary of California.

[14] As shown by the land-use map, the boundary lines of the various regions do not cut across any important crop area, but traverse the range. Consequently, the particular location of these lines does not indicate significant differences in range types. For discussion of range differences, see page 95.

GEOGRAPHIC DISTRIBUTION OF FIELD CROPS

The geographic distribution of crops and types of livestock in California is shown quantitatively by dot maps, based on county statistics of crop acres harvested in 1929 and livestock numbers on farms April 1, 1930, as reported in the 1930 Census of Agriculture.[15] As far as possible, the dots have been distributed within the counties so as to reveal the existing localization. This has been accomplished by reference to field mapping and local statistics from various sources compiled by subdivisions within the counties.

Although California grows a greater variety of crops than any other state, most of the farmers are crop specialists. Tree fruits, vines, and other perennial plantings involve large initial expenditures, require specialized equipment, and, when once established, tend to be perpetuated for a number of years. Such enterprises do not lend themselves to crop rotations nor, for the most part, to general systems of farming, but they are particularly adapted to specialization. The small grains, which constitute the largest acreage of any crop, are grown mainly without irrigation, either annually or alternately with fallow every second or third year in areas where other crops cannot be grown profitably. In limited areas, beans or peas are rotated with small grains under dry-farming conditions; but with these and other minor exceptions, crop rotations or cropping systems are confined to the irrigated sections. Even here, crop rotations are relatively simple, consisting mainly of truck or field crops rotated with alfalfa, with occasional covercrops for soil improvement. Because of the large number of products that can be grown in many areas, the cropping schemes follow no set pattern but tend to be highly irregular in comparison with standard rotations outside the state. Thus, the absence or irregularity of crop rotations in some areas necessitates the analysis of California crop geography on the basis of commodities rather than cropping systems.

ALFALFA

Alfalfa is produced in every county (except San Francisco) and assumes considerable importance in certain agricultural areas. As it is grown mainly under irrigation, plantings are concentrated especially in the irrigated sections of the Sacramento, the San Joaquin, the Imperial, and the Palo Verde valleys, and in the southern coastal plain. Less extensive acreages occur in the larger valleys of the Coast Ranges, and minor acreages in the interior mountain valleys (see fig. 9).

[15] United States Bureau of Census. Fifteenth Census of United States, 1930. Agriculture. The western states. vol. 2(3):532–70. 1932.

Alfalfa grows under a wide range of conditions. Plantings in California are to be found at altitudes ranging from below sea level to 4,000 feet or more in elevation; in climatic zones ranging from the hot, arid desert (wherever irrigation is available) to the cool, moist conditions of the coastal plains and valleys; and on soil types ranging from light sandy loams to heavy adobe.

Alfalfa is grown for hay, seed, alfalfa meal, and pasture, and is the chief legume for soil improvement. Because of its high nutritional value,

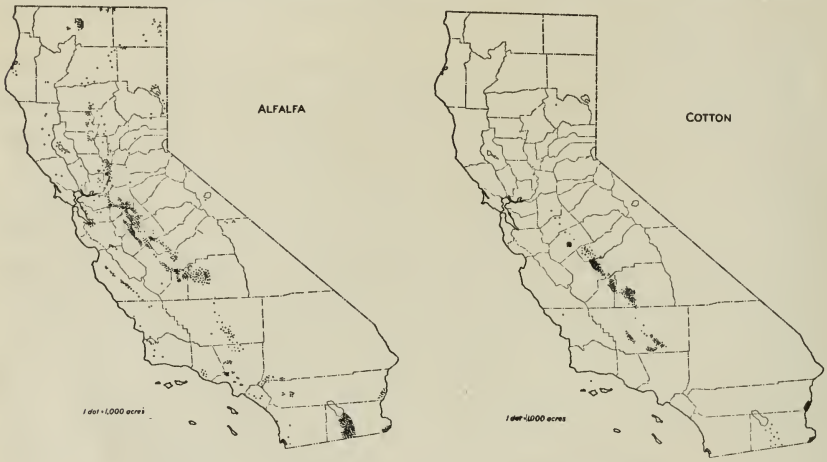

Fig. 9.—Distribution of alfalfa and cotton acreages.

the hay is the preferred roughage for feeding livestock, particularly dairy cows. Its wide adaptability, together with its various uses, accounts for its widespread distribution throughout the state.

COTTON

Cotton is confined distinctly to the interior valley and desert regions, with the greatest concentration of plantings in the middle and southern San Joaquin Valley. It has been grown extensively in the Imperial, Palo Verde, and the Yuma valleys of the desert region, and, to a minor extent, in the Sacramento Valley (see fig. 9).

The major influences controlling the localization of cotton plantings are the climate, the availability of irrigation, and the value of competing crops. The climate of the San Joaquin Valley and of the desert is suitable because of the long, hot, growing season and the freedom from rainfall during harvest. As rainfall in these areas is insufficient in amount or inadequate in distribution to produce this crop, plantings are confined to irrigated lands. The principal influences deterring the expansion of the cotton acreage in the Sacramento Valley are the lack of ther-

mal units (that is, heat units), which retards the date of maturity, and the fall rains during harvest, which interfere with picking and affect the quality adversely. Thus, in this region, other crops have generally been more profitable, and cotton has not become important.

In the Imperial Valley, cotton was first grown commercially around 1910. Acreage and production increased rapidly until 1920, when approximately 104,000 acres were planted and a crop of 39,000 bales (estimated) was produced. Cotton was then the most important crop, and the Valley was the cotton center of the state. Subsequently, acreage and production in the Valley declined markedly, mainly because of the shift to the rapidly expanded truck-crop industry, and concurrently the center of production shifted to the San Joaquin Valley where cotton production expanded rapidly after 1925.

California produces, almost exclusively, an upland type of cotton known as the Acala variety. Under the prevailing environmental conditions, this variety produces large yields of relatively long-staple cotton of superior quality. Because of its superiority and the early recognition of the advantages of specialization in one variety, legislation enacted in 1925 makes it unlawful to plant, pick, harvest, or gin any cotton other than "Acala" within the defined "one-variety cotton districts"[16] comprising all counties from San Joaquin to Kern in the San Joaquin Valley and in Riverside County.

As may be seen from figure 9, this act applies to most of the present cotton-producing area and accounts for the predominance of the Acala variety. Some long-staple Egyptian types, among which Pima and Mebane are the present favorite varieties, are usually produced in the Imperial and Yuma valleys.

FLAX

The commercial production of flaxseed in California is a recent development. Before 1934 occasional small plantings, mainly experimental, were made in various sections. In that year the first crop of commercial importance was reported when approximately 11,000 acres were harvested in the Imperial Valley. The apparent success achieved was due, in large measure, to experiments conducted by the California Agricultural Experiment Station in coöperation with the United States Department of Agriculture in determining varieties and cultural practices suited to the area; and the results led to a rapid expansion of the acreage

[16] California Statutes 1925, p. 491, approved May 22, 1925; now embodied in: [California] Agricultural Code, 1939. Division 5 (Standardization), Chapter 5, Article 3, Sections 951–54 (One Variety Cotton District).

In 1941, the California legislature amended the act to omit Riverside County from the "one-variety cotton districts."

in the Imperial Valley and to the extension of plantings into the San Joaquin and Sacramento valleys.

Yields have ranged annually from about 14 to 17 bushels per acre. Varieties and cultural practices thus far developed apply directly to certain environmental conditions and have been tested commercially only in selected areas. Although further experimentation is being carried on in potential flax-producing districts, the results are not conclusive enough to warrant commercial planting.

Flax must have a longer growing season than barley or wheat. It requires also a cool growing season, being retarded in both growth and production by high temperatures. The seedling, in comparison with those of the grains, is very weak and will not long withstand below-freezing temperatures, drought, alkali, or competition with many of the common weeds. Though medium soils are preferred, good yields may be obtained on any of several types that are well drained and not affected with alkali. Obviously, however, flax has a narrower range of adaptability than the grain crops and will probably be confined to the irrigated sections of the interior valleys, with the possibility that plantings may be extended into coastal areas where irrigation facilities exist or where late spring rains may be depended upon. Though there is undoubtedly a much larger area suited to flax culture than has been planted to date, its limits have not yet been established.

LARGE GRAINS

The crops constituting the large-grain group—corn, grain sorghums, and sunflowers—occupied only from 2.5 to 3.0 per cent of the harvested acreage of the state in recent years. As shown in figure 10, the production of large grains is concentrated in the Sacramento—San Joaquin Delta. In addition, there are scattered acreages throughout the Great Valley and in the south, particularly in the Imperial Valley.

Corn has not become prominent in California agriculture because, even when irrigated, it does not thrive under the arid summer climate of the interior and because the winter climate is too cold for it to be grown as a winter crop. The coastal areas, likewise, are too cool for its profitable culture. In the Sacramento—San Joaquin Delta, where the principal acreage of field corn is grown, the summer temperatures are modified generally and the humidity is increased considerably by the low elevation, the prevalence of water courses, and an almost continuous sea breeze. The general practice of subirrigating the lands by means of deep cross ditches offsets the lack of summer rains and contributes materially to increasing atmospheric humidity.

The grain sorghums, being more heat- and drought-resistant than

corn (maize), are better adapted to the arid climatic conditions and are grown over a much wider area. In some sections they can be grown without irrigation, but throughout the Great Valley and the south, irrigation is generally necessary. Where water is available, however, grain sorghums seldom constitute the major crop, because returns from other products have usually been greater.

Sunflower seed, which markedly resembles the grain sorghums in production practices and requirements, is confined mainly to the vicinity of Manteca in San Joaquin County. Although adapted to a much wider

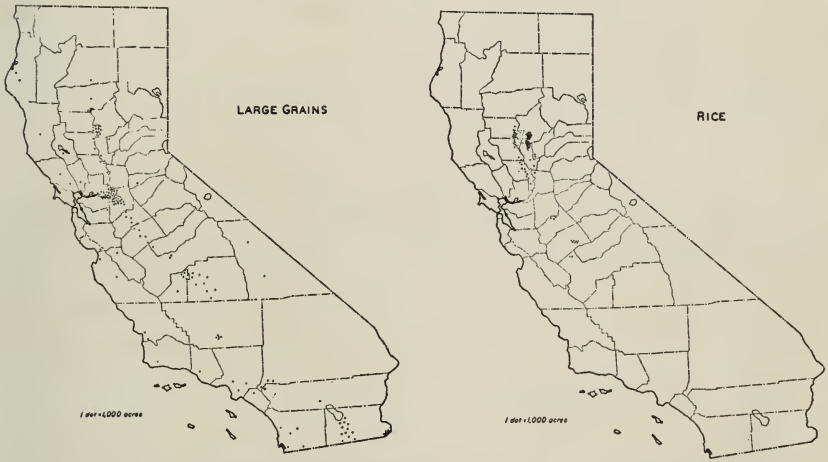

Fig. 10.—Distribution of large grains (maize, grain sorghums, and sunflowers) and rice.

area, as is indicated by the small acreages usually planted in Riverside and Yolo counties, limited demand and lack of marketing facilities have tended to limit its production. Its principal use is for poultry feed.

RICE

Rice growing (fig. 10) is confined to well-defined areas in the Sacramento and San Joaquin valleys that meet its specific requirements. These are a long, warm growing season, freedom from rains during harvest, an ample and continuous supply of irrigation water, adequate drainage, and soils retentive of moisture.

As the climate of the interior valleys is generally suitable, the factors determining areas within which rice can be produced economically are mainly the soil and the availability and cost of water. Because a soil highly retentive of water is required, rice can utilize soils of very heavy texture and those underlain with hardpan at such shallow depths that

they are of limited value for other crops. The aquatic nature of this plant during its growing period necessitates the use of large amounts of water, especially on soils least adapted to the requirements of the crop. For economical production, therefore, an abundance of relatively cheap water is required.

Where these conditions prevail, rice has become established as a major crop, frequently being rotated with the small grains or with fallow every third or fourth year, to dry out the lands and to control the weed growth.

Besides the acreage in the principal areas, rice production has been carried on over a period of two to three years or more as part of a process for reclaiming lands impregnated with alkali. Usually, if the process proves successful, the reclaimed lands are then utilized for more intensive types of agriculture. Rice production in these areas is therefore only part of a transitional process in the development of the land.

SMALL GRAINS AND HAY OTHER THAN ALFALFA

Although California is known principally for its specialty crops, in 1929 the small grains, grain hay, and volunteer or natural grass hays occupied more than 2.9 million acres, or about 43.7 per cent of the harvested crop acreage of the state. There have since been only slight changes in acreage or in proportion of the total. These crops are produced in all arable sections, as indicated in figure 11. Their widespread distribution may be attributed to their hardy nature, their adaptation to a wide range of conditions, and their utilization as cash crops or as supplementary feeds for livestock on the range.

Fig. 11.—Distribution of small grain and hay. This includes barley, oats, wheat, rye, and all hay crops other than alfalfa.

The cereals may be planted in most parts of the state during the late fall or early spring, maturing crops of hay in April or May, or of grain in June or July. As the growing period coincides with the rainy season, these crops can utilize the annual precipitation better than most others. The small grains, therefore, can be grown under dry-farming conditions over a much wider area than most other crops; the heavy concentrations of these crops occur in areas that have large bodies of nonirrigated cropland, notably the Sacra-

mento Valley and portions of the San Joaquin (fig. 11). Besides the acreages on the valley floors, the cereals and volunteer hay are grown also on the rolling foothills, on the less precipitous slopes of the Coast Ranges, and in the mountain valleys.

Some grain and grain hay are produced on irrigated lands as part of crop rotations or as feed for the farm livestock. Where sufficient water and suitable soil may be had, however, crops of greater value have, for the most part, supplanted grains in the irrigated sections.

Grains.—Barley, wheat, and oats, in the order named, are the important grains produced in California (fig. 12). Barley and wheat are grown principally in the interior valleys, particularly the Sacramento, under both dry-farmed and irrigated conditions. Producing areas of less importance are the Imperial, Salinas, Shasta, and their tributary valleys. These cereals are not grown to any extent within the fog belt where the cool, humid climate is not conducive to high yields. Barley greatly exceeds wheat in acreage in the Great Valley because it usually yields enough more per acre to offset the price advantage of wheat. This yield varies, however, with the productivity of the soil and the availability of moisture, the relative advantage being greatest on the poorer soils and in the drier areas. Of late years about one fourth of the California barley has been exported or used locally for malting.[17] This grain usually commands a higher price than feed barley and in some years has sold for nearly as much per pound as wheat. California wheat, on the other hand, is practically all of the "spring white" type, which commands no premium price. Although barley and some wheat are exported, the state is on a net-import basis for both these commodities.

Oats thrive in the cooler and more humid climate of the coastal region and in the central part of the Great Valley, which is subjected to coastal influence. The area favorable for oat production is limited, constituting only a small part of the grain-producing area. In the coastal region the California Black (Coast Black) oat is grown almost exclusively for both grain and hay. Production is confined mainly to the counties bordering on San Francisco Bay. In the interior, oats are grown on the lower foothill stretches bordering the eastern side of the Great Valley, principally from Yuba County on the north to Merced County on the south, but the crop is of minor importance in this area as compared with barley or wheat. The Kanota and the California or Texas Red oat are the leading varieties produced in this belt because of their superior resistance

[17] From 1931–32 to 1936–37 the proportion of the total supply (carryover plus current crop) exported and used locally for malting ranged from 18.3 to 32.1 per cent, averaging 24.5 for the period. Data from: Federal-State Market News Service, San Francisco office. Semi-annual barley review. July 2, 1937. (Mimeo.)

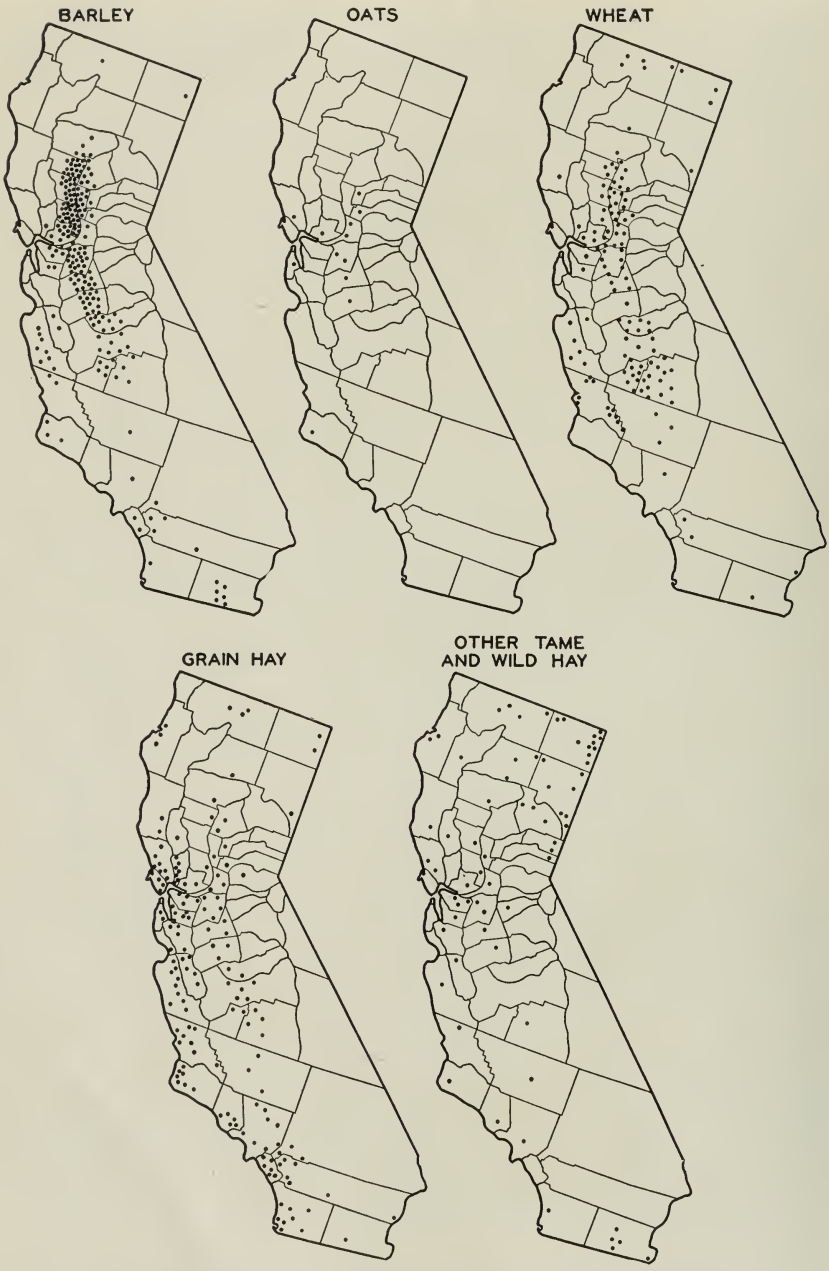

Fig. 12.—Distribution of barley, oats, wheat, grain hay, and other hay crops. One dot = 5,000 acres.

to drought and heat during the maturing period. Since the principal varieties of oats grown in California are inferior in milling quality, most of the acreage is cut for hay, and only limited amounts are threshed for grain.

Rye, an unimportant crop in California, competes favorably with the other small grains only in sandy soils or where the winters are cold, as in the northern mountain counties. In this section, rye is a more dependable crop, and a considerable acreage of it is cut for hay. Under more favorable conditions, barley, oats, or wheat, the choice of crop depending on climatic and soil conditions, is usually more profitable than rye, and the hay cut from these crops is preferred for livestock feeding.

Over large parts of the dry-farmed grain areas there are no alternative opportunities for cropping. Lands that cannot be planted profitably with grain or grain hay are left to produce volunteer crops of native grasses for hay or for pasture. Shifts in the relative prices of the various grain and hay products cause corresponding shifts in the acreage planted to each type of crop and in the amount of each harvested as grain or hay.

Hay.—Grain hay is distributed more widely than the other crops in this group. The reason is perhaps twofold: first, cereals will make hay in areas where the moisture supply is inadequate for grain; and second, the crop is grown mainly to supplement the range feeds of beef cattle and sheep. The greater acreage of cereals cut for hay rather than grain in the central-coast and south-coast counties and in the southern San Joaquin Valley is attributable mainly to the insufficiency of moisture in these areas.

Some hay is produced in grain-growing districts where lanes are mowed around the borders in order to open fields for the combines. In addition, during years of drought or damaging frosts, considerable acreages of grain that fail to mature are frequently cut for hay.

The miscellaneous hay crops consist largely of wild hay, to a lesser extent of nonleguminous tame hays, and to a minor extent of timothy and clover mixtures, clovers alone, and annual legumes cut for hay. These different types are found for the most part in the northern mountain counties (fig. 12). Over much of this area, particularly at higher elevations, the growing season is short, and conditions are not conducive to the production of cereals either for grain or for hay. Much of the agricultural land is in the mountain valleys which, having abundant moisture, form native meadows. These, especially when improved by the introduction of clovers and of such tame grasses as brome, rye, and timothy, yield luxuriant crops of grass hay that can be produced at less expense than grain hay under these conditions.

Most of the grain and wild hay is utilized locally or on the farms where

produced. There is a market for grain and wild-oat hay for feeding horses and—to a less extent—beef cattle and dairy stock, but the demand is limited because alfalfa hay is generally preferred for this purpose.

GEOGRAPHIC DISTRIBUTION OF ROW CROPS

California produces a vast array of cultivated truck and field crops. All these, except the field crops described earlier, fall under the general classification of row crops. They are usually grown on a field-scale basis in intertilled rows the same as are the large grains. Although plantings occur in many parts of the state, much of the acreage is concentrated (fig. 13) in the lower Sacramento and San Joaquin valleys, including the Delta; the coastal areas from San Francisco Bay south; and the Imperial and Coachella valleys in the desert.

Fig. 13.—Distribution of row crops.

The classification of row crops includes both cool- and warm-weather plants. The former thrive in the temperate and more humid atmosphere of the coast and as late fall, winter, or early-spring crops in the interior valleys. The warm-weather plants are grown in the interior valleys, in irrigated sections of the desert, and in parts of the coastal valleys protected from the direct coastal influence.

For the most part, these crops are of high unit value and contribute materially to the agricultural income of their production areas. The importance of the income derived from any one of these crops is accentuated by the fact that most of them are not grown over an extensive area of the state but rather are confined within limited cropping belts.

ARTICHOKES (GLOBE)[18]

The commercial production of globe artichokes in the United States is confined to the five central-coast counties of California, from Marin on the north to San Luis Obispo on the south (see fig. 14). Within this area, plantings are limited to parts of the fog belt where the soil and

[18] The globe artichoke is not to be confused with the Jerusalem artichoke. Although members of the same family, they are not closely related. The edible part of the globe artichoke consists of the receptacle and lower portion of the bracts of the young flower head, whereas the edible portion of the Jerusalem artichoke is a tuberous root.

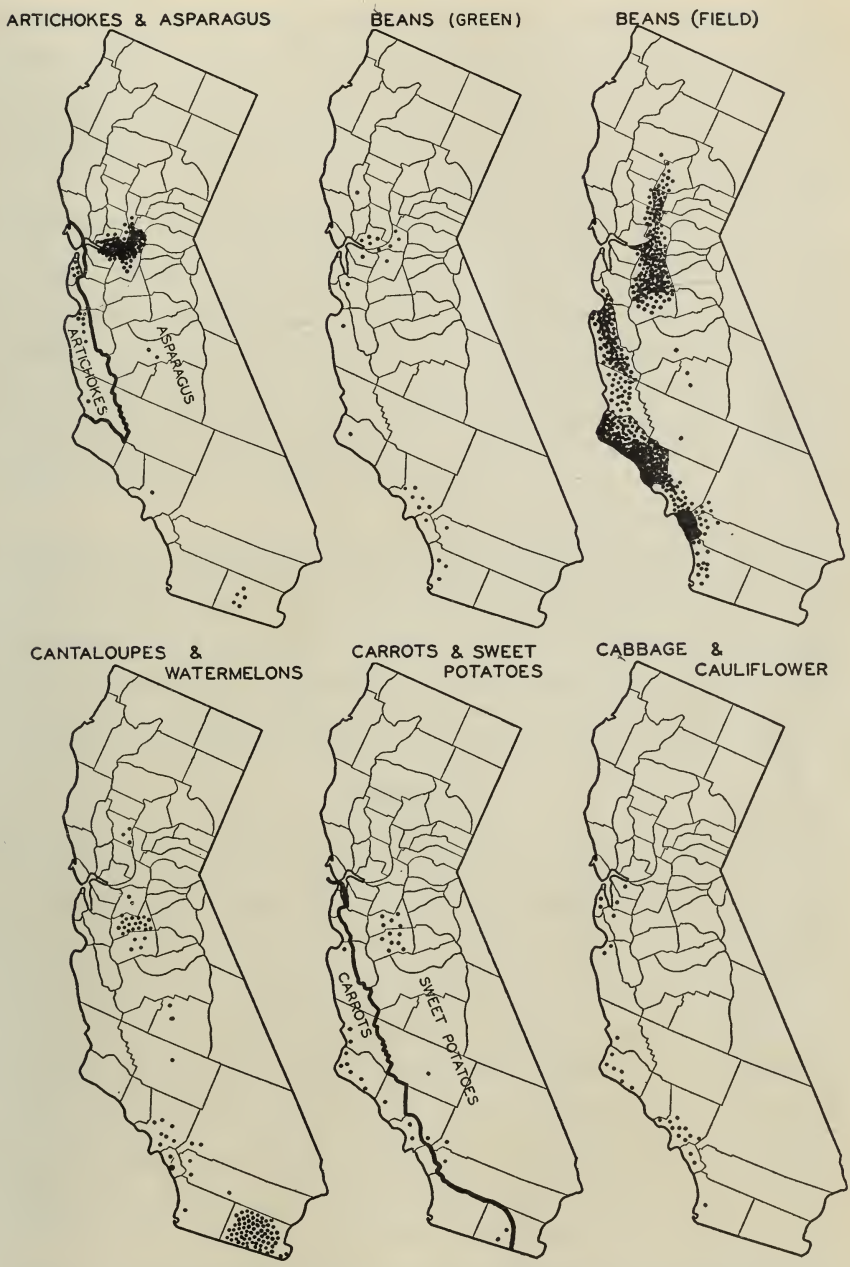

Fig. 14.—Distribution of artichokes, asparagus, green and field beans, cantaloupes, watermelons, carrots, sweet potatoes, cabbage, and cauliflower. One dot = 500 acres.

the irrigation facilities are suitable. Although this plant will grow on various soil types, it is exacting in its climatic requirements, thriving only in a cool, humid climate, yet being easily damaged by frosts. It is grown successfully, therefore, only in frost-free areas within the fog belt of the coastal region. Much of the present acreage lies on the gently sloping benchlands facing the ocean.

Though the globe artichoke has long been established as a commercial crop in the central-coast counties, production increased only slowly until after 1915, when the decline in imports from southern Europe stimulated a rapid expansion to the 1925–26 peak of 11,760 acres, with an estimated production of 1,470,000 boxes of 40 pounds each.[19] As the markets then were not sufficiently developed to absorb at remunerative prices the large supplies produced from 1925 to 1927, acreage declined sharply. In 1932, production amounted to only 6,330 acres and 570,000 boxes. Since that year, however, replanting has gradually increased the acreage to more than 10,000 in 1937.

The harvest period extends from September 1 to May 1, with heaviest shipments in February, March, and April. Although marketed while there is a minimum of competition from other fresh vegetables, the artichoke is not well known in the large consuming centers; only spasmodic attempts have been made to popularize it or to introduce it to new markets. Consequently, while much larger supplies can be produced, the limited demand holds this industry to a relatively small scale.

ASPARAGUS

Of the total asparagus acreage of the United States, approximately 63 per cent is in California, which produces annually more than one third of the fresh asparagus grown and nearly all of the canned. The rest of the total supply is obtained from plantings widely scattered along the Atlantic seaboard, in the midwestern states, and in Oregon and Washington. Evidently, then, this plant grows under a wide range of climatic and soil conditions. Though it will survive low winter temperatures and high summer temperatures after the harvest, freedom from extremes of either heat or cold is essential during the growing season, for the spears are very susceptible to frost, and the quality is impaired by heat. Although adapted to a wide range of soil types, it thrives best on a deep, friable, well-drained soil of light texture, which must be kept moist throughout the growing season by either rainfall or irrigation.

Over 90 per cent of the asparagus acreage of California is in the delta

[19] Stokdyk, E. A. Marketing of globe artichokes. California Agr. Exp. Sta. Bul. 524:5–7. 1932. (Out of print.)

of the Sacramento and San Joaquin rivers (fig. 14). Here conditions are particularly favorable: the soils—mainly a mixture of muck and sediment—are particularly well adapted to this crop; irrigation water is available; and the temperatures are modified by the sea breezes which, entering through the Carquinez Strait, fan out over the Delta. The remainder of the acreage is confined mainly to the Imperial and San Fernando valleys in the south and to the Mendota area of Fresno County.

The California crop is the first to reach the markets each year. Harvest in the Delta and in the Imperial Valley begins in February, in the other areas in March, and continues through June. The product in excess of local requirements is shipped to eastern markets until about April 1, when eastern supplies begin to compete. Thereafter the California crop is canned, except for that consumed locally. The Imperial Valley also produces a fall crop, harvested from October to December, which is shipped fresh.

BEANS (GREEN)

Snap, or string, beans of both the bush and pole varieties are grown mainly in the lower Sacramento and San Joaquin valleys in areas adjacent to the Delta and in the coastal area of Los Angeles, Orange, and San Diego counties. Minor acreages are to be found in the bayshore area of Alameda and Santa Clara counties and in the Salinas, Santa Maria, and Coachella valleys. In the Upper Lake district of Lake County a limited acreage of the Creaseback variety is canned, producing a pack of exceptional quality. In the south-coast region, centering in Los Angeles and Orange counties, a comparatively small acreage of lima beans is picked green for local consumption and for shipment, mainly by truck or in mixed carlots, to northern state and out-of-state markets.

Beans for the fresh-vegetable trade require a moderately warm climate during the growing season, yet they withstand neither extreme temperatures nor aridity. They are grown, therefore, only where the climate is modified by coastal influences. As they are adapted to a wide range of soils, the most important factors determining their localization are climatic conditions and irrigation facilities in areas of scant rainfall.

The chief limitation to the production of green beans, however, is lack of demand for the crop. Should the market expand, the production could be greatly increased in many, if not all, of the present tested producing areas.

Although green beans are available locally during most of the year, the main harvesting and shipping season for the spring crop is April and May; for the fall crop, September through November. Green limas are available only in late summer and fall.

BEANS (FIELD)

Field beans are among the important crops, occupying annually about 5 per cent of the total crop acreage and usually more than 35 per cent of the acreage in row crops. Their production (fig. 14) centers chiefly in three regions of the state—namely, the south coast, the central coast, and the Great Valley from Merced County north to Tehama County. Extreme heat precludes the planting of beans in the southern San Joaquin Valley and in the desert, and the lack of thermal units during the growing season precludes their culture in the north-coast and mountain regions. Within the remaining areas, where moisture and tillable land are available, conditions are favorable.

The ten important commercial varieties of field beans produced in this state are, in order of importance: lima, Pink, baby lima, Blackeye, and Small White, which together constitute usually from 85 to 90 per cent of the total production; and Cranberry, Mexican Red (California Red), Red Kidney, Lady Washington, and Bayo, which largely make up the remainder. Each of these varieties excels under somewhat distinct environmental conditions, minute though the differences may be; and each has a somewhat different market outlet, though not wholly without competition from other varieties.

Lima.—Although more lima beans are grown in California than any other beans, this type is the most exacting in its requirements, and its production area is the most narrowly circumscribed. It grows to perfection only in the warm fog belt of the south coast, and repeated attempts to grow it elsewhere have failed. The central- and north-coast regions are not warm enough to ripen lima beans, and the interior valleys are too hot and dry to permit the setting of many pods. Baby limas, while possessing many lima characteristics, are more tolerant of aridity and high temperatures during the growing season. Plantings are made, therefore, in the upper reaches of the coastal valleys, in the San Fernando and other interior valleys of the south coast, and in the Sacramento and northern San Joaquin valleys. Dry lima and baby lima beans are staples on the markets of the United States and Canada. The large limas are marketed mainly in the northern part of the United States, the baby limas in the southern states. These beans are also used, both dry and green, for canning.

California virtually monopolizes the production of both lima and baby lima beans. For several years, plantings of both types were restricted to the south coast, and with the limited supplies produced, prices averaged considerably higher than for other beans. Production of large limas is still restricted to the same area, but since the development of new

varieties of baby limas, more tolerant of heat and drought, plantings have been extended over wider areas of the interior valleys. The resulting increased production has tended to depress prices, and since they compete directly with large limas in the consuming markets, prices of the latter likewise have dropped to lower levels.

Pinks.—Of all the varieties produced in California, the Pink bean has the widest range of adaptation, being raised in all bean districts of the state. Centers of production are the Sacramento Delta, where this variety predominates, the King City district of the Salinas Valley, and throughout the Great Valley from Tehama County south to Madera County. Plantings are also made in the upper reaches of some valleys in the south-coast region. About 95 per cent of the United States supply of Pink beans is grown in California. The principal markets are in the southwestern states and in Cuba, where a colored bean is in demand. The Pinto bean of Colorado, New Mexico, and Wyoming competes actively, however, with the Pink.

Blackeye.—The Blackeye bean (Blackeye cowpea), though more tolerant of heat and drought than the other varieties grown in California, is very sensitive to cool weather and reacts unfavorably to the coastal climates. It is therefore grown in the warmer and more arid sections, production centering in the upper Sacramento Valley, the middle San Joaquin Valley, and the interior areas of the south-coast region. California meets with but little competition in producing Blackeyes and finds a ready market in the southern states, for the Negro population prefers these beans to any other variety.

Small White.—The Small White bean and the closely related Blue Pod variety are well adapted to the moderate temperatures and humid conditions of the central-coast region and cannot be successfully grown in the hot interior. They are raised in the lower reaches of the Salinas, Santa Ynez, and other coastal valleys of this region. California production amounts to only 5 per cent of the United States supply. On the markets the Small White faces direct competition with the large white beans. It possesses, however, superior canning qualities, and the demand for canning varieties has maintained prices for these beans in the face of increased production in the United States.

Cranberry.—Cranberry beans require a rich soil well supplied with moisture and are sensitive to extreme heat. The Sacramento Delta and the river-bottom lands south of Sacramento, where the United States supply of this bean is grown, are well suited to its culture. It has a distinct and somewhat limited market in the mining districts of the eastern states. Competition for use of the land, however, holds the acreage in check. This competition is with Pink beans, which yield more heavily

but usually command a somewhat lower price; with Bayos, for which both yield and price are about the same as for Cranberry beans; and with other crops suited to the area.

Mexican Red.—The Mexican Red (California Red) bean has about the same range of adaptation as the Pink and was formerly grown throughout the same general territory, southern California excepted. Before 1926, California produced practically the entire United States supply, but since then an increased volume of production from Idaho and other areas, with an attendant lower level of prices, has caused a retraction of acreage in this state. At present, production of Mexican Reds is confined mainly to the Sacramento and northern San Joaquin valleys. The principal markets are the southwestern states and the West Indies.

Red Kidney.—The production center for the Red Kidney bean is the lower Sacramento and San Joaquin valleys. Plantings are concentrated mainly in the vicinities of Marysville and Stockton with only minor acreages elsewhere. This variety, having a relatively short growing season, can be planted on overflow or other lands that cannot be planted early. It is not a prolific bearer, and though successfully grown on upland soils, its low-yielding habit limits its ability to compete with other more-favored varieties in these areas. Red Kidney beans produced in the Great Valley, however, are free from bacterial blight and anthracnose. Recognition of these desirable characteristics has resulted in a marked increase in demand and in price for the California crop for use as seed in New York and other producing districts in the East. Thus, while this bean cannot compete generally with other varieties on the basis of yield, the demand and premium price paid for a large part of the crop as seed beans permit its successful competition and have led to a marked increase in production since 1930.

That part of the California crop not sold for seed is usually exported to Cuba or Puerto Rico, where it is the favored variety for the manufacture of chili con carne. In years of short crops in the eastern states, it finds a ready market along the Atlantic seaboard.

Lady Washington.—The Lady Washington, a large white bean, is grown in the same general areas as the Pink and the Mexican Red. It is less prolific than either of these varieties in all but the central-coast bean areas. Though formerly grown extensively, its low-yielding habit, coupled with increasing competition from other areas including the Orient, has resulted in a marked decline in California acreage.

Bayo.—The Bayo, like the Cranberry bean, is grown on the river-bottom lands south of Sacramento and in the Delta. These two varieties, having similar characteristics and requirements, may be interchanged

in the production program. As the market demand for Cranberries is generally greater, the acreage of this variety exceeds that of the Bayo. The principal outlets for Bayo beans are the mining and lumber camps of the Pacific Coast and the Mexican trade of the Southwest.

CABBAGE AND CAULIFLOWER

As cabbage and cauliflower are cool-weather plants possessing similar requirements for growth, their production is confined largely to the same general areas—mainly the central- and south-coast regions (fig. 14). In the former, plantings occur near the San Francisco Bay, in the lower Salinas Valley, and in the Santa Maria and Santa Ynez valleys. In the south-coast region, production is confined principally to the coastal plain from Ventura to San Diego County and to the San Fernando and San Gabriel valleys of Los Angeles County. In these sections the concentration of one crop or the other occurs as a result of minor differences in soil and climatic conditions.

Some cabbage is harvested and shipped from California every month, but the bulk of shipments is made from December to June. Cauliflower is harvested mainly from November to June, although usually a few carlots are shipped during each of the remaining months of the year.

CANTALOUPES AND MELONS

Production of cantaloupes and melons—of which Casabas, Honey Balls, Honeydews, Persians, and watermelons are the principal types—centers in two producing areas, the Imperial Valley and the San Joaquin Valley. The remainder of the acreage is composed of rather widely scattered plantings in the southern interior and Sacramento valleys (fig. 14). Melon plants require a warm growing season and adequate soil moisture, particularly as the crop approaches maturity. Production is confined, therefore, to the irrigated sections of the interior valleys where loam and sandy loam soils of suitable quality are available. These soils are preferred because they warm up earlier in the spring, are readily permeable and easily worked.

The importance of the Imperial Valley as a cantaloupe- and melon-producing area is attributable largely to the earliness of its crops: harvest of the early (covered) spring cantaloupe crop usually begins in April, followed two to three weeks later by the main (uncovered) crop.[20] The peak of shipments is reached during May and June and tapers off during July. The other areas follow in turn from south to north, ending

[20] For the early crop, young plants are frequently protected from frost and wind damage with paper covers set over each hill; in addition, windbreaks of brush and paper are sometimes used. Crops so protected mature from 4 to 10 days earlier.

with the harvest of the small acreages in the middle Sacramento Valley in August and September. A small fall crop, maturing in October, is usually grown in the Imperial Valley.

Watermelons and other melons are harvested mainly from May to August in the Imperial Valley and from July to October elsewhere.

Except for the later-maturing crops, a considerable proportion of the total is shipped out of the state. Although no authentic data are available, local estimate indicates that one third to one half or more of the melon acreage in the Sacramento Valley is utilized for seed production, the remainder being shipped to local markets.

CARROTS

Carlot shipments of carrots from California are made every month, though the heaviest are from October to June. The principal centers of production are the Imperial Valley, the lower Salinas Valley in Monterey County, the Santa Maria and Santa Ynez valleys in Santa Barbara County, and the coastal sections of Los Angeles and Ventura counties.

The carrot, being primarily a cool-weather crop, is produced mainly in coastal areas or as a winter crop in the interior. The potential producing area within the state is much greater than that actually used.

LETTUCE

Lettuce is one of the most important truck crops grown in California. Of the row crops produced in 1929 it ranked second only to beans in both acreage and value. Since then it has been exceeded, in acreage only, by beans, sugar beets, and tomatoes, retaining its position as second to beans in value of the row crops. Up to 1920 lettuce was of minor importance. Accompanying the increase in demand for fresh vegetables in the United States during the decade 1920–1930, its production in California increased rapidly from about 6,000 acres and 2,000 carlot shipments in 1920 to a peak of more than 117,000 acres and 38,700 carlots in 1930–31.

The large volume of shipments, coupled with a material decline in consumer purchasing power, resulted in unprofitable returns to growers and curtailment of plantings to a new low of 93,100 acres in 1933. During the ensuing four years, acreage ranged from an estimated 99,200 to 114,400, averaging approximately 105,500 annually. During this period, production averaged about 13,880,000 crates a year (equal to 43,400 carlots). Since 1930–31, carlot shipments of lettuce originating in this state have exceeded two thirds of the total United States shipments in most years, and California has become the leading lettuce-producing state.

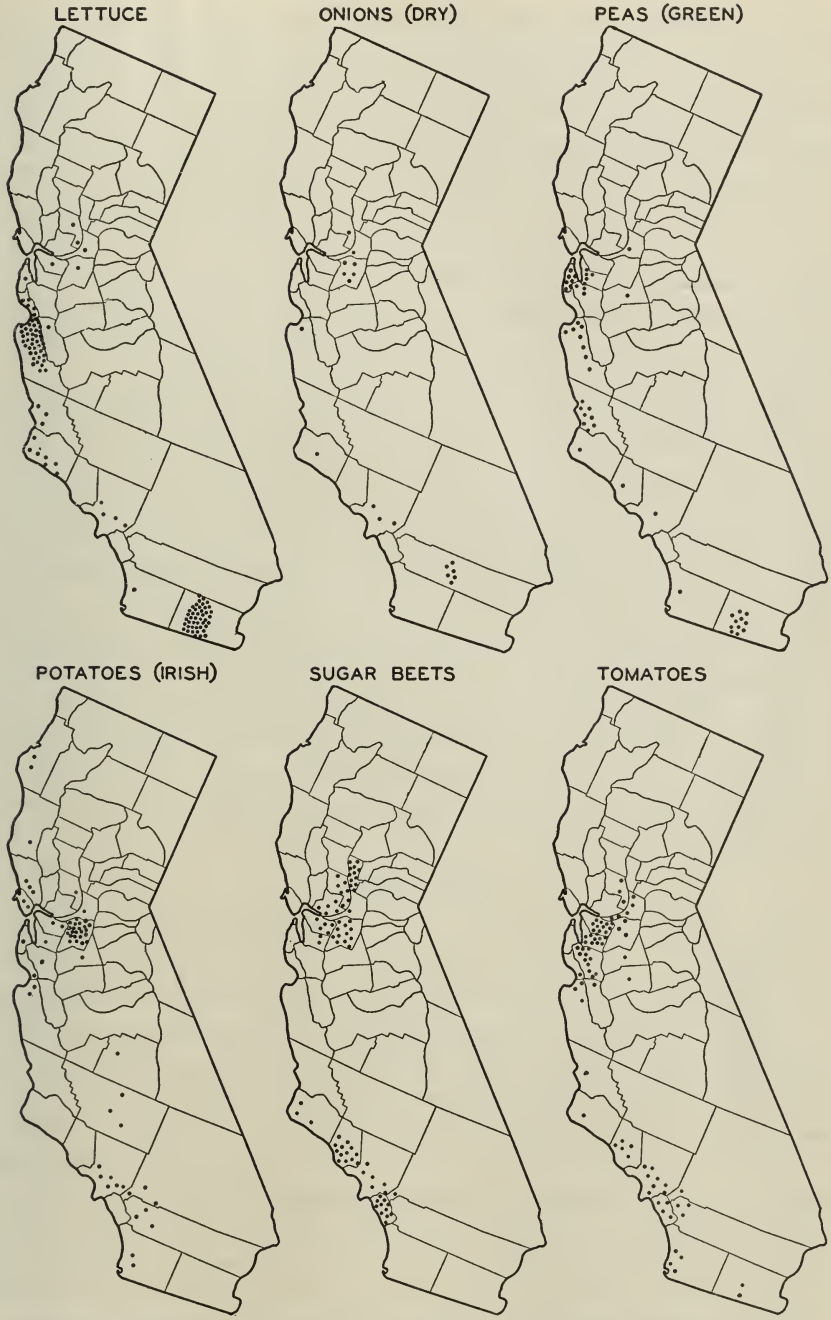

Fig. 15.—Distribution of lettuce, onions (dry), peas (green), potatoes (Irish), sugar beets, and tomatoes. One dot = 500 acres.

This industry was expanded not only by increasing the acreage in established producing areas, but also by changing certain techniques and practices and by extending plantings into areas previously considered unsuited for commercial production of lettuce. The favored and only important commercial type produced in this state is the New York variety known to the trade as "Iceberg" type. Under favorable conditions this produces a compact, firm head greatly preferred in many markets to the Big Boston type produced in the eastern states. Head lettuce of high quality can be grown only where temperatures are moderately cool and uniform while the crop is maturing and where soil moisture can be maintained throughout the growing season. Plantings are therefore confined to irrigated lands of the interior valleys and the coast.

The present major producing areas (fig. 15) are the Imperial Valley and the Salinas-Watsonville district, comprising the lower Salinas Valley and the Pajaro Valley. Of less importance are the Santa Maria and San Fernando valleys, the San Francisco Bay area, the south-coast counties, and scattered areas throughout the Great Valley. In the Imperial Valley, lettuce is a winter crop, harvested mainly from December to March, usually with peak shipments in January and February. The other interior valleys produce both a fall crop, harvested in November and December, and a smaller spring crop, harvested usually during April and May. In the coastal areas spring, summer, and fall crops are grown with plantings so staggered that the harvest extends from April to December. Thus, carlot shipments originate in California every month, with the usual peak for the spring crop occurring in May and June, for the fall crop in October and November.

ONIONS (DRY)

The principal onion-producing areas are the Sacramento—San Joaquin Delta, the Shafter district of Kern County, the lower Salinas Valley, and the Coachella Valley. Numerous small acreages are scattered throughout the interior valleys, particularly in the central and southern parts of the state. Onions prefer cool weather early in the growing period and moderately high temperatures thereafter. They are grown, therefore, as a late spring and summer crop in the interior valley and coastal region, and as a late winter crop in the desert. Loams, sandy loams, and muck soils of the Delta are the principal types utilized for onion production. Since one essential to successful culture of this crop is adequate and uniform soil moisture during the growing season, irrigation facilities are practically indispensable. The Bermuda type (principally the Yellow Bermuda and the Crystal White Wax varieties) predominates in the Coachella and in the southern San Joaquin valleys, whereas

in the other areas the main varieties are Australian Brown, California Early Red, Italian Red, and Yellow Globe Danvers. Harvest in the Delta is mainly from June to September; in the other central areas from late May to July; and in the desert from April to June. Though carlot shipments are made throughout the year, the period of greatest movement is from May or June to September, coincident with the harvest in the major producing areas.

PEAS

The two principal pea-producing areas (fig. 15) are the Imperial Valley and the coastal region from San Francisco south to San Diego County. In the latter, plantings are concentrated in the San Francisco bayshore area, on the seaward slopes of the hill lands in San Mateo and San Luis Obispo counties, and in the Salinas, San Benito, Santa Maria, and Santa Ynez valleys. Since 1929, acreage has markedly increased in the Great Valley, especially in Sacramento, San Joaquin, Stanislaus, and Tulare counties. Minor acreages are to be found in the Point Reyes section of Marin County, the Fort Bragg section of Mendocino County, and here and there throughout the southern coastal plain.

Both fall and spring crops are grown in the Imperial and Salinas valleys and in the San Francisco bayshore area. Fall crops predominate in the upper San Joaquin Valley; spring crops in the Sacramento and northern San Joaquin valleys and in the coastal sections of San Luis Obispo and Mendocino counties. The variation in climatic conditions provides for a succession of crops maturing every month in one area or another. Local markets are almost continuously supplied and some carlot shipments can be made throughout the year. The bulk of the shipments of the spring crop, however, is from April to June, and of the fall crop, from October to December.

The pea is a cool-weather plant able to withstand considerable frost during its early stages and adaptable to a wide range of soil types. From blossoming to maturity, however, it requires a moderately cool and even temperature, being then susceptible to damage both by frosts and by heat. It thrives, therefore, in the moderated climate of the coastal region and can be grown in the interior valleys only as a fall or early-spring crop.

Because of its winter-growing habit it can utilize the natural precipitation, a characteristic which, coupled with its resistance to drought, permits its production in many unirrigated areas. Except in the Imperial Valley, where both fall and spring crops are grown on irrigated land, most of the spring plantings are on dry-farmed lands. Plantings are therefore to be found on the hill lands and benches bordering the

valleys and on the seaward slopes facing the ocean. Part of the summer crop and most of the fall crop in all areas are grown on irrigated lands. Thus the relatively hardy characteristics of the pea and the variations in climatic conditions in different parts of the state largely account for its widespread distribution.

POTATOES

Irish potatoes are among the less important but most widely distributed row crops grown in California (fig. 15). The greatest acreage is concentrated in the San Joaquin Delta, where high yields are obtained on the organic and sedimentary soils and large-scale operations predominate. The Delta normally contains about one third the acreage and produces nearly half the total state output of potatoes. Of secondary importance are the Shafter-Wasco section of Kern County and the Tulelake section in Siskiyou County. The rest of the acreage is confined to relatively small areas, widely distributed, each with certain advantages of soil, climatic conditions, or shipping season.

Except in the Delta and small acreages in the north-coast and mountain areas, the harvest is well in advance of the shipping season of the main United States potato crop. The earliest potatoes produced in California come from the scattered acreages in the coastal sections of San Diego County. These are dug and shipped to local markets from February to April, followed in turn by the harvest in the Colma district (on the ocean side of San Mateo County) from April to July and in the Shafter-Wasco section from May to July. In the several areas of the southern coastal plain and the interior valleys of Los Angeles, Riverside, and San Bernardino counties, both early-spring and late-fall crops are grown for local markets, but the main crop matures from June to August. In the Delta, harvest generally extends from July to December.

In the coastal region minor concentrations occur in the lower Salinas and Pajaro valleys, in the Tomales and Sebastopol areas of Marin and Sonoma counties, and on the coastal benches of Mendocino and Humboldt counties. Harvest in these areas and in the northern mountain counties, particularly the Tulelake section of Siskiyou County, occurs during the fall and winter.

From approximately 63,300 acres and 8.2 million bushels in 1919 potatoes showed an almost continuous decline to 31,600 acres and 6.5 million bushels in 1929. During most of this period California was on a net-import basis for potatoes. Though some early potatoes were shipped out of the state, particularly to the Northwest, a much larger volume—mainly from Idaho, Oregon, and Washington—was shipped in during the fall and winter to supply local markets. Thus, despite freight dif-

ferentials favoring the local growers, the potato crop did not prove highly profitable and was displaced by other crops. Since 1931, however, relatively low prices for many of the competing crops have reversed the trend, and potato acreage increased annually to a new peak in 1937 of approximately 65,000. Much of this increase has occurred in the early-producing areas, principally in Kern County and in the recently reclaimed lands of the Tulelake section of Siskiyou County.

SUGAR BEETS

Sugar-beet production in 1929 (fig. 15) centered in the Sacramento and northern San Joaquin valleys, including the Delta, in the coastal sections of Ventura, Los Angeles, and Orange counties, and in the San Fernando Valley. In previous years considerable acreages were planted in the Salinas, Santa Maria, Arroyo Grande, and Santa Ynez valleys, but during the decade 1920–1930 this crop was largely displaced by a rapidly expanded truck-crops acreage.

The sugar-beet acreage in California declined from the peak of 162,000 in 1917 to 46,000 in 1929. This decline is attributable largely to two factors: the ravages of the curly-top disease, transmitted by the small beet leafhopper, *Eutettix tenellus* (Baker); and the displacement of beets on better lands by various truck crops, for which the price was higher during this period. Since 1929, however, the farm price for sugar beets has been relatively more favorable than for many competing crops; the disease has been effectively controlled through the development of resistant strains; production techniques have been changed to permit early plantings; and crop rotation has proved necessary or desirable in some areas. The result has been a notable increase in sugar-beet production in the areas mentioned above, together with extension of plantings into the middle and southern San Joaquin Valley. Thus, a noticeable shift in concentrations of plantings has occurred since 1929. There have been marked increases in the Sacramento Valley, centering in Yolo and extending into adjoining counties, and also in the Salinas and other valleys of the central-coast region. In the southern producing areas, on the other hand, acreages have increased only moderately.

Climatically, these areas are suitable because of the long, warm, growing season, which permits the beets to mature normally, and the absence of rain from June to October permits an uninterrupted harvest. Irrigation is generally required to mature a crop. The beet thrives on a variety of soils and will tolerate more alkali than most field crops. Its production is extended, therefore, into areas where the soil conditions are not suited to many other field and truck crops.

Sugar beets are grown almost exclusively under contract with sugar-

refining companies. At the harvest, beets are dug in accordance with a schedule established by the company and are shipped by truck or by rail to a designated refinery.

SWEET POTATOES

Sweet-potato production centers principally in the irrigated sections of Merced, Stanislaus, and San Joaquin counties (fig. 14). Producing areas of less importance are the Colton district in San Bernardino and Riverside counties, the San Fernando Valley in Los Angeles County, and the Shafter district in Kern County, with scattered plantings elsewhere. Since the sweet potato is a warm-weather plant requiring a frost-free period and mean temperatures of more than 70° F for at least 120 to 130 days, it is ideally suited to the interior valleys. It thrives only on light sandy loam soils where adequate moisture may be maintained by surface or subirrigation. In the Merced-Stanislaus area, sweet potatoes are grown under irrigation on the lighter phases of the Fresno sandy loams and on the Oakley and Fresno sands (undifferentiated); in the other producing areas, on irrigated soils of suitable texture and quality.

The two main types raised commercially in the state are represented by the Yellow Jersey and Nancy Hall varieties. The Yellow Jersey type has a dry, mealy flesh, generally creamy to golden yellow; the Nancy Hall and a similar variety, the Porto Rico, known to the trade as "yams," have moist, sweet flesh with a light to deep pink caste in the raw state. The Jersey type predominates at present because of the preference of many western markets for a dry, mealy potato. Practically the entire crop from the southern areas is consumed locally. The San Joaquin Valley supplies local markets and provides shipments for the Northwest and Rocky Mountain states. Harvest begins in August and continues three to four months. The potatoes are usually harvested according to current demand until the first frost, when the remainder are dug immediately and put in storage. The heaviest shipments are from September to December but may continue as late as March from out-of-storage stock.

TOMATOES

Tomato production centers mainly in the counties bordering the south and east shores of San Francisco Bay, in the lower Sacramento and San Joaquin valleys, and in the interior valleys and coastal plain of the south-coast region. Minor acreages are found in the Coachella, Imperial, and middle San Joaquin valleys and in the central-coast counties. Tomatoes require a long, warm, growing season but will withstand neither extreme temperatures nor aridity. Hence, production is confined mainly to

areas where summer temperatures are modified by coastal influence or where the growing season is long enough to permit the maturing of crops before high temperatures occur. Thus, in interior valleys and in the desert, plantings are made in selected areas to mature the crops from April to June, usually well in advance of excessive or damaging heat. The plant thrives on a wide variety of soil types but tolerates neither alkali nor excessive moisture. The lighter soils are generally used for early crops, the heavier soils for late crops. In most areas irrigation is practiced to supplement the rainfall, but a considerable acreage near the San Francisco Bay is unirrigated. Except in the desert region, tomatoes are grown during the summer; hence in favored areas, where irrigation is available, double cropping with spinach or other winter truck or field crops is a common practice.

Tomatoes are produced for fresh market, for canning, and for the manufacture of juice, paste, puree, sauce, and other products. Although tomatoes for fresh markets are harvested in California throughout the year, carlot shipments out of the state are usually made only between April and December. Earliest shipments originate in the Coachella and Imperial valleys, followed by spring and summer crops from the southern coastal and the northern producing areas. The peak of shipments is reached in October during the combined harvest of the fall crop from both north and south, exclusive of the desert.

Most of the stock for canning and processing is produced in the San Francisco Bay area and in the Great Valley between Yolo and Sacramento counties on the north and Merced County on the south. Smaller supplies from late summer and fall crops are produced in the south-coast region.

MISCELLANEOUS ROW CROPS

Besides the row crops mentioned above, California produces many miscellaneous vegetable and other specialty crops that occupy relatively minor acreages but provide important revenue to certain communities and growers. Most of this produce comes either from the truck-crop areas, previously indicated, or from market gardens near centers of population. Much of it is consumed locally, although a part contributes materially to the total United States supply. Certain specialty crops, however, are rather distinctive in production requirements or uses and are therefore grown only in selected areas.

Peppers.—Bell, or sweet, peppers are produced mainly in the Santa Clara and Santa Maria valleys and in the coastal sections of Los Angeles, Orange, and Ventura counties. Small, scattered acreages are planted throughout the San Joaquin and interior valleys of the south. Carlot shipments to local and out-of-state markets are made occasionally from

the San Joaquin Valley in June and July and regularly from the coastal valleys in October, November, and December.

Chili peppers and pimientos are produced almost exclusively in the south-coast plain. Although the center of production is the Garden Grove district of Orange County, plantings are made near the coast in Los Angeles, San Diego, and Ventura counties. Peppers are both canned and dried; pimientos are produced for canning only.

Bush Fruits.—Bush fruits (chiefly Young, Boysen, Logan, and other blackberries; currants; gooseberries; and raspberries) occupied, in 1929, about 3,450 acres, distributed rather widely over the central and southern part of the state. Individual plantings usually comprise side-line enterprises on the smaller farms. Los Angeles County leads in producing blackberries, and is second to Santa Clara County in producing raspberries. Alameda and Tulare counties lead in currants; in gooseberries, Alameda is followed by Monterey County. Though some out-of-state shipments are made, most of these fruits are marketed locally. In recent years there has been some canning and preserving, but only up to a small percentage of the total production.

Flower and Vegetable Seeds.—Flower and vegetable seeds are grown usually under contract with commercial seed companies in various parts of the Great Valley and in the central and southern coastal areas. In the interior, production centers largely in Sacramento, San Joaquin, and Yolo with smaller acreages in Butte, Colusa, Kern, Stanislaus, and Sutter counties. In the coastal region the most important producing areas are the Hollister-Gilroy district of San Benito and Santa Clara counties, the lower Salinas Valley, and the coastal valleys of Santa Barbara County. A large volume of mustard seed is produced annually in one of these, the Santa Ynez Valley—the only area in California where this crop is grown. Minor acreages of seed crops are also found in the three southern counties of Los Angeles, Orange, and Riverside. Judging from developments in the Cotati district of Sonoma County, this area will become prominent in producing vegetable seeds.

Garlic.—Garlic is grown mainly in the central-coast region, with production centering in the San Juan district of San Benito and Santa Clara counties. Scattered minor acreages are planted also in the San Joaquin and lower Salinas valleys. Since 1930 from 2,000 to 3,000 acres have been used annually for this crop, a large part of which is shipped to eastern markets.

Hops.—Hop production is confined largely to the Russian River valleys from Ukiah (Mendocino County) to Santa Rosa (Sonoma County) and to the Sacramento Valley in the counties of Sacramento, Sutter, Yolo, and Yuba. In both regions discontinuous plantings are found on

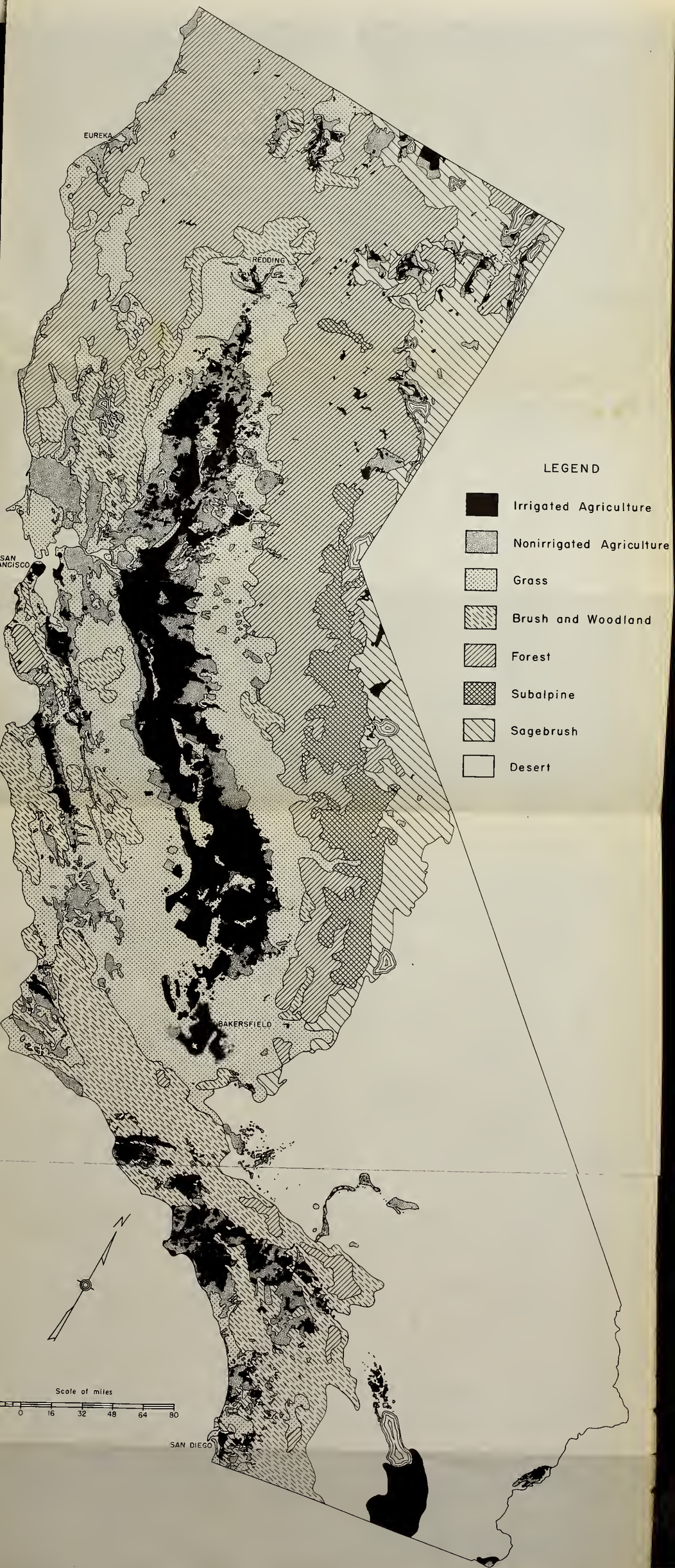

Plate 1. Agricultural land use and natural cover. A composite of the available information on location of brush, desert, forest, grassland, arable lands both irrigated and non-irrigated. (Data supplied by the United States Forest Service including the California Forest and Range Experiment Station; California State Department of Public Works Division of Water Resources; California Agricultural Experiment Station, particularly the Division of Irrigation and the Department of Forestry; and field surveys by the authors.)

the sedimentary soils bordering the rivers. Although there are a few large hopyards in each area, individual plantings are relatively small, generally from 20 to 40 acres in size and are frequently combined with other enterprises as part of a diversified-farming program.

In 1929 the Census of Agriculture reported 4,144 acres of hops in the state. Encouraged by somewhat higher prices during 1932 and 1933 and by the legalization of beer of full alcoholic content, growers expanded their plantings to 7,500 acres in 1934. Since, however, production in other areas increased simultaneously, the market became demoralized, and retrenchment necessary.

Strawberries.—Strawberries are produced for local consumption over a widespread area from Humboldt County on the north to the Imperial Valley on the south. The principal producing and shipping centers are the Florin district of Sacramento County and the Artesia—Garden–Grove district in Los Angeles and Orange counties. Of secondary importance are Fresno and San Joaquin counties in the interior-valley region, the bayshore area of Alameda and Santa Clara counties, and the Pajaro Valley in Santa Cruz County.

Shipments of strawberries from the south and from the interior valleys are made from April to June; those from the San Francisco bayshore area, from July to September. On local markets, however, supplies are usually available during eight or nine months of each year.

Other Crops.—Besides these miscellaneous row crops, more than thirty vegetables, kitchen herbs, and medicinal crops are grown commercially, but in relatively small quantities. Although these are mainly for local consumption, some are shipped regularly out of the state in mixed carlots, a few in straight carlot loadings. For the most part this produce comes from the truck-crop belts already mentioned, the cool-weather types being raised in the coastal sections, the warm-weather types in the interior valleys and in upper reaches of the coastal valleys.

GEOGRAPHIC DISTRIBUTION OF DECIDUOUS-TREE FRUITS AND NUTS

Practically all types and many varieties of the deciduous-tree fruits and nuts found in the United States are produced in California. These are grown (fig. 16) in both coastal and interior valleys and, to a lesser extent, along the Sierra Nevada foothills, where soil and moisture permit. The general requirements are fairly deep soils retentive of moisture, adequate water supplies, winter temperatures low enough to break the rest period of the trees, freedom from late, spring frosts, and relatively long, warm growing seasons. The mountain regions, in general, are not adapted to fruit growing because of a rough topography and a

short growing season. In the desert, the winters are too mild to break the rest period; the summers too hot and arid to produce fruit of good quality. In most areas otherwise adapted to tree fruits and nuts, the rainfall is usually inadequate in amount or distribution to insure successful production. Except, therefore, in certain areas of the north- and central-coast regions and, to a lesser extent, the Sierra Nevada foothills, irrigation is generally relied upon to supplement the rainfall. Plantings in areas subject to occasional unseasonable spring frosts, but otherwise adapted to tree-fruit production, are made possible by the use of orchard heaters, but this practice materially increases the costs of production.

Fig. 16.—Distribution of deciduous-tree fruits and nuts.

The tree fruits have been grouped into two classes: the temperate-zone crops, which include the deciduous-tree fruits, nuts, and small fruits; and the subtropical fruits—avocados, citrus, dates, olives, and several fruits of minor importance having the same general requirements. The various tree crops grade all the way in climatic requirements from apples (which thrive in cool, temperate climates) to avocados (in subtropical climates) and dates (in the hot desert). Because of this gradation, the tree-crop classification produces borderline cases that might logically be classed with either group.

It is not to be supposed that within the entire area used for deciduous-tree fruits and nuts (fig. 16), all species and varieties can be grown to equal advantage. Soil and moisture conditions, temperature relations, and minor climatic effects markedly influence yield and quality of fruit, pest infestation, and the timeliness of maturity of the crop. Hence, besides the general requirements for growth, each species or—to a lesser extent—each variety requires different conditions for successful commercial production. Variation in environment from place to place within the deciduous-tree-crop belt contributes to the marked localization of the various types and varieties of tree fruits grown.

APPLES

Though apples are grown throughout the state, over two thirds of the present acreage lies in two principal producing areas—the Sebastopol district of Sonoma County and the Watsonville district of Santa Cruz

and Monterey counties. Scattered plantings are to be found in Humboldt and San Diego counties and at selected locations in the Sierra Nevada foothills at elevations ranging from 1,700 to 4,500 feet—principally in Tuolumne, Butte, Tulare, El Dorado, Mariposa, and Kern counties (fig. 17). Minor concentrations occur in the Napa and lower Santa Clara valleys, the Beaumont-Yucaipa district of Riverside and San Bernardino counties, and Mendocino County centering in the Anderson Valley. Because apples require a somewhat cooler temperature during the growing season than do most other deciduous fruits, production is confined mainly to areas under the modifying coastal influence or to foothill and mountain valleys at moderate elevations.

The Sebastopol district specializes in the Gravenstein variety, devoting to it more than two thirds of the apple acreage. Most of its production of market grades is marketed within the state but some is shipped to widely distributed out-of-state markets concurrently with the harvest in July and August. Drying and processing are also important aspects of apple production in this district. Usually most of the lower grades and miscellaneous varieties—from 35 to 50 per cent of the total crop—are utilized for these purposes. The orchards are located mainly on the eastern slope of Gold Ridge—a low elevation variable in width and about 14 miles in length in southern Sonoma County—but extend in scattered plantings up the Russian River valleys to Geyserville. The Gold Ridge soils are, in general, fine, sandy loams; the topography is rolling and unsuited to irrigation; and the climate is intermediate in character between coastal and interior valley. The annual precipitation, which normally exceeds 30 inches, permits the production of apples without supplemental irrigation.

In the Watsonville district, plantings (mainly of Yellow Newtown and Yellow Bellflower) are located largely in the Pajaro Valley and on the bordering slopes. As climatic conditions are decidedly coastal, the red varieties seldom attain the desired color and therefore are not grown in any quantity. With rather cool temperatures, high humidity, and a normal rainfall of about 20 inches, irrigation is seldom necessary. The crop matures in the early fall and in general is shipped loose in lug boxes by rail and truck to local markets, particularly in the south. A part, however, is packed for export trade and shipped during the fall.

In the Beaumont-Yucaipa district, apples are grown in scattered plantings that total about 2,000 acres on mesa lands at elevations of 2,500 to 3,000 feet. Summer temperatures at these altitudes are modified considerably, the days being warm and sunny, the nights characteristically cool. During the winter the low temperatures insure a break in the rest period of the trees. The rainfall, usually about 20 inches, is sup-

plemented by irrigation from wells in order to increase the size of fruit. Among the several varieties of apples grown, the most important are the Rome Beauty, the Delicious, and the Winesap. Most of the fruit is sold unpacked in lugs on the Los Angeles and other local markets. Apples

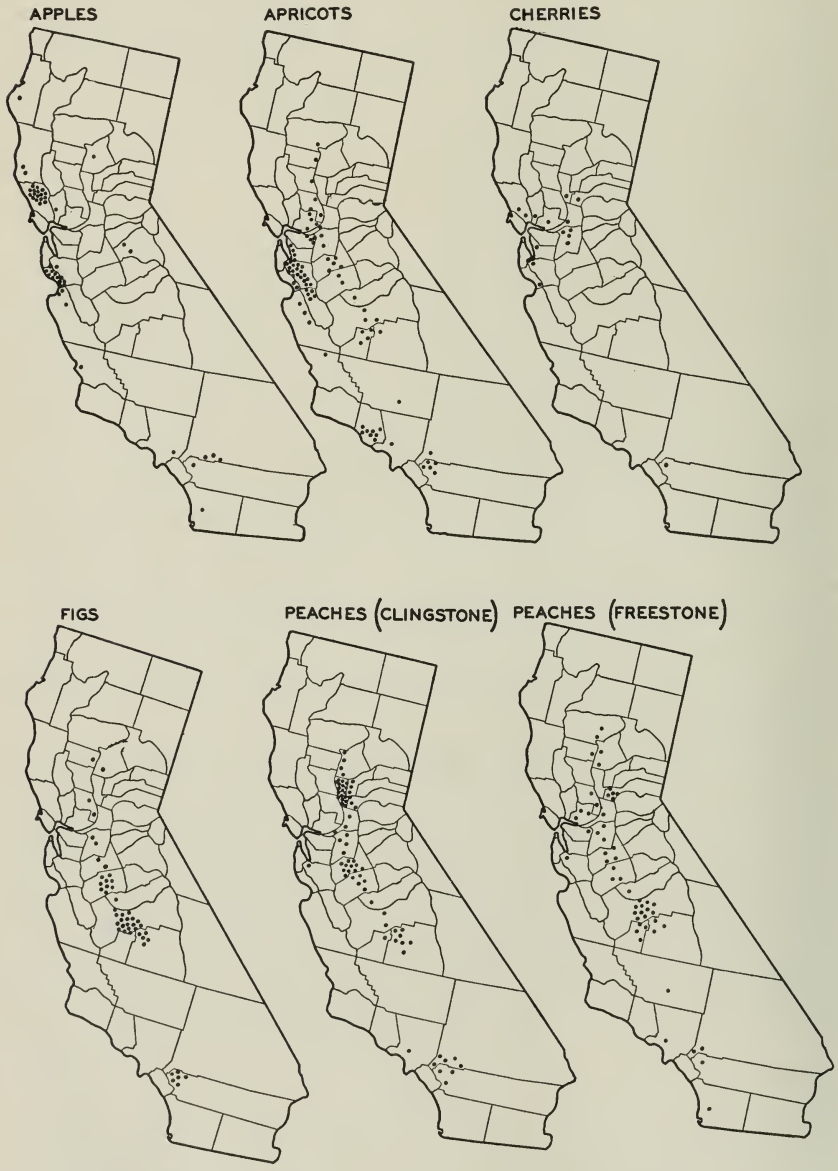

Fig. 17.—Distribution of apples, apricots, cherries, figs, and clingstone and freestone peaches. One dot = 1,000 acres.

are raised also for local consumption in numerous small scattered areas throughout Los Angeles County and in the Adelanto-Victorville section of the desert in San Bernardino County.

In the Sierra Nevada foothills, Tuolumne County leads in acreage and production. Here apples are grown in scattered blocks at elevations ranging mainly from 2,000 to 3,500 feet. Although the rainfall in most places is normally sufficient, some irrigation is practiced where water is available. The quality of the crop is good, and the fruit is shipped mainly to markets within the state.

In the Anderson Valley of Mendocino County, several varieties and a considerable tonnage are produced, but because of time of maturity, quality of the apples, and lack of transportation facilities, most of the crop is dried. While a few carlots are usually shipped from the Santa Clara and Napa valleys, the production from these and other areas mentioned, as well as from the other acreage scattered throughout the state, is relatively small and is mainly consumed locally or processed.

APRICOTS

Apricot production centers in the Santa Clara and San Benito valleys, Alameda and Contra Costa counties, in selected areas of the Sacramento and San Joaquin valleys, in the Santa Clara River Valley of Ventura County, and in the Hemet section of western Riverside County. Since the tree is fairly adaptable to soil conditions, its distribution is controlled largely by climate. Because of its early-blooming habit and consequent susceptibility to spring frosts, sites must be carefully selected. Plantings tend to be concentrated on the higher lands in the valleys to insure good air drainage, and on the adjacent hillside slopes wherever soil and moisture permit.

Apricots are produced for shipment to fresh-fruit markets, for canning, and for drying. In recent years (1935–1939) from 61 to 74 per cent of the entire state crop each year has been dried, from 17 to 32 per cent canned, and usually somewhat less than 10 per cent shipped fresh to eastern and local markets. The amount utilized in each of these three ways depends largely on the price anticipated or offered. Although only a relatively small proportion is shipped fresh regularly, this aspect of the industry is nevertheless important in districts where the crop matures early.

The early districts in which most of the out-of-state shipments originate are the Vacaville, Winters, and Arbuckle districts of Solano and Yolo counties and the Brentwood district of Contra Costa County. Smaller supplies are sent from the southern San Joaquin Valley and the Santa Clara Valley; a few carlots, from the south. The shipping

season extends usually from about May 15 to July 15. Most of the crop from the central-coast districts matures in June and July and is utilized for canning. In the interior valleys and in the southern districts a large part is dried, but in some years a considerable tonnage is canned, and the remainder consumed locally.

CHERRIES

The commercial production of cherries in California is confined to the sweet type, which is shipped to fresh-fruit markets and processed in various ways. Although cherries are grown in all but five counties, most of the acreage (fig. 17) is located in the counties abutting on San Francisco Bay; in the interior-valley counties of San Joaquin, Placer, Sacramento, and Sutter; and in the Beaumont district of western Riverside County.

Although the cherry is very exacting in both its climatic and soil requirements, the limitations to its successful culture are not clearly understood. For its best development, the tree requires a deep, medium-textured, moist, yet well-drained soil. Being particularly susceptible to variations in soil moisture, it will neither grow nor produce satisfactorily on sandy or heavy, wet soil. Climatically it apparently prefers moderate temperatures and some humidity during the growing season. In the central part of the state, most of the plantings are in areas subjected to coastal influence, although a considerable acreage occurs in the interior valley on lands bordering the Sacramento River and its tributaries. In the south, cherries are grown at elevations of 2,000 to 3,000 feet, where the summer climate is milder and the winter climate is sufficiently severe in most years, to break the rest period.

The principal varieties of cherries grown in the state are, in order of importance, the Royal Ann (Napoleon), Bing, Black Tartarian, Lambert, Republican (Black Oregon), and Chapman. Several varieties are grown in each district and frequently in individual orchards. The black types predominate in all except the Occidental district of Sonoma County, where the Royal Ann, a white-fleshed cherry used mainly for canning and processing, is produced in largest quantity. Important acreages of this variety occur also in San Joaquin, Santa Clara, Alameda, and Napa counties.

The earliest cherries usually mature in late April or early May, and are nearly all shipped to out-of-state markets. Most of the crop is shipped during May and June, with only limited supplies coming from the coastal districts in July. California cherries are the first to reach the markets, and the main harvest is completed before supplies from other areas compete appreciably.

FIGS

Figs are planted widely over the central and southern parts of the state, but commercial production centers in Fresno, Merced, Tulare, San Joaquin, Madera, and Stanislaus counties, which contain over 85 per cent of the present bearing acreage. Numerous scattered plantings occur throughout the Sacramento Valley, particularly in Yolo, Glenn, and Butte counties, and in the southern counties of Riverside and Los Angeles. Although the fig is a deciduous tree, its climatic requirements approach those of the subtropical group. It requires a long, warm growing season, low humidity, and high summer temperatures. Cold winters or frosts during the spring are detrimental and frequently determine the suitability of an area for fig production. These requirements prevent the crop from being grown successfully in the cool, humid atmosphere of the coast and in mountainous regions.

From less than 6,000 acres in 1914, fig acreage was expanded rapidly, so that by 1928 a peak of 47,000 acres had been brought into bearing. This rapid increase resulted largely from promotional activity, and since, in some cases, sites were not carefully selected, large acreages proved unproductive. Because of this situation, combined with widespread infestation of endosepsis in the Smyrna-type varieties and low prices over a period of years, acreage and production have gradually declined. Not all of the unproductive or unprofitable plantings have been removed as yet, hence the location of present bearing acreage (fig. 17) reflects promotional activities as well as conditions that are really suited for production. With further experience, producing areas may be shifted gradually to more favorable locations, providing the economic status of the industry warrants the relatively large investment per acre required by this enterprise.

Although numerous varieties are grown throughout the state, commercial production of figs for fresh shipment, for drying, and for canning is confined mainly to six leading varieties: Adriatic, Calimyrna, Kadota, Mission, Turkey, and Brunswick. The first four named are dried in considerable quantities; the last two are usually shipped fresh; and the Kadota is the leading canning variety. For the four-year period ending in 1937, production of dried figs averaged approximately 24,100 dried tons annually. Of the fresh fruit, during the same period, an average of approximately 4,800 tons a year was consumed locally or shipped, and 5,173 utilized for canning. Much more of the production could be utilized each year for fresh shipment, but the perishable nature and high cost of handling figs as a fresh fruit restricts the volume that can be profitably disposed of through this channel.

PEACHES

Most of the canning and dried peaches, but only a small part of the United States supply of fresh peaches, are produced in California. Both clingstone and freestone types are grown, the former mainly for canning, the latter for canning, drying, and fresh consumption. Because of differences in dates of maturity and characteristics suited to different uses or demands, several varieties of each type are grown. Of the clingstone varieties, the Tuscan (Tuskena), which matures late in July, and the Phillips Cling, which ripens in August and September, were formerly favored by canners because they interfered least with the canning of other fruits during July and because desirable midsummer varieties were not then available. More recently the Hauss, Paloro, Peak, Gaume, Halford, and other improved midsummer peaches have met with considerable favor for canning. Some clingstone varieties are shipped fresh, and small quantities occasionally are dried. For this latter purpose clingstones are poorly adapted because of the expense involved in drying them; yet with proper handling a good product can be obtained.

Muir and Lovell, both freestones, are the preferred drying varieties because of their low drying ratio, excellent product, and midseason maturity giving time for the process to be completed before the fall rains begin. Though less well suited for drying, the Elberta and other freestones are dried regularly or occasionally in considerable amounts.

The shipping season for California peaches begins in the latter part of May and continues, with a succession of maturities of varieties and areas, through September. Of the many varieties grown for the fresh-fruit trade, the Elberta and the J. H. Hale are at present most important.

Climatic conditions in the interior valley are well suited to peach culture. The long period of bright sunny days, the low humidity, and the high summer temperature produce fruit of high quality. Diseases and pests, in the main, may be readily controlled.

In soil moisture requirements, the peach differs but little from the apricot. Since it blooms somewhat later than almonds, apricots, and some plums, it can be grown successfully over a wider area than these fruits. Climatic conditions in coastal sections and parts of southern California are not, however, well suited to peach culture. The cool, damp atmosphere of the coast areas favors the development of brown rot and other fungus diseases and does not provide sufficient thermal units during the growing season. In the southern counties, except for the foothills, winter temperatures are frequently too mild to break the rest period. When such conditions prevail, blooming and the beginning of growth are greatly delayed, and only small crops are set.

Because of these characteristics and requirements, peach production centers in the Great Valley and in western San Bernardino and Riverside counties. The canning-peach industry centers in Sutter and its adjoining counties in the eastern Sacramento Valley (fig. 17). Clingstones also predominate in Stanislaus, Merced, and San Joaquin counties and in the south. Acreages of freestones are distributed somewhat more uniformly with greatest concentrations in Fresno and Tulare counties in the San Joaquin Valley and in the foothill section of Placer County. This latter area specializes in the production of shipping peaches. The Atwater, Livingston, and Modesto sections of Merced and Stanislaus counties and some areas in Fresno and Tulare counties produce freestones for eastern shipment, but most of the crop in the San Joaquin Valley is dried. The high temperatures, the aridity, and the lateness of the rains provide favorable conditions for an excellent sun-dried product. In Solano, Yolo, and Tehama counties, freestone peaches predominate and are used both for shipping and for drying and are encountering increased favor for canning.

PEARS

Pear production (fig. 18) centers mainly in the lower Sacramento Valley and in the Sierra Nevada foothills of Placer, El Dorado, and Nevada counties, with important acreages in selected areas of the coast region from Mendocino and Lake counties on the north to San Luis Obispo County on the south. Minor plantings are to be found in the southern counties, and only scattered acreages elsewhere in the state. Within these areas, pears are relegated frequently, but not entirely, to locations unsuited to other deciduous fruits because of climate or soil. The pear tree tolerates heavy or wet soils better than most fruits and because of its late-blooming habit can be grown where the frost hazard is too great for many deciduous trees.

The coast region contains the greatest total acreage. Plantings north of San Francisco Bay are concentrated largely on the south and west shores of Clear Lake in Lake County, in the Russian River valleys of Mendocino and Sonoma counties, and in the Napa Valley. South of the Bay the principal concentration is in Santa Clara Valley, though important acreages also occur in San Benito County and in the coastal sections of Santa Cruz and Monterey counties. In the Sacramento Valley, or in the so-called "river district," production centers in Sacramento County and includes most, if not all, the pear acreage in the adjacent counties of Solano, Contra Costa, Yolo, San Joaquin, together with the less important acreages in Sutter and Yuba. Elsewhere within this valley pears are of relatively minor importance. Pear blight, which first ap-

peared in epidemic form in 1900 in the San Joaquin Valley, virtually wiped out the industry in that area and subsequently caused the abandonment of acreages in the northern Sacramento Valley and other areas. It has not only deterred new plantings in these districts but has also contributed largely to the expansion of the pear acreage in the coast region where this disease, though epidemic, has seldom done extensive damage. Control measures now in use, though costly, have proved effective in the present producing areas, except in a few years when conditions were particularly bad.

Third in acreage and production is the Sierra Nevada foothills district, where plantings occur in scattered areas along the slopes up to elevations of about 2,500 feet in El Dorado, Placer, and Nevada counties. In the south the principal acreage is in the Antelope Valley of Los Angeles County. Smaller concentrations are to be found in western Riverside and San Bernardino counties and near Tehachapi in Kern County.

Several varieties of pears are grown in California. The Bartlett predominates, occupying 83.7 per cent of the standing acreage in 1937. The remaining acreage is devoted to fall and winter varieties, of which the Hardy, Winter Nelis, Bosc, Comice, and Anjou in the order named are the most important. The Bartlett is the favorite becaue of its superior canning, drying, and shipping qualities. Besides this three-way outlet for the crop, California Bartletts mature considerably in advance of pear crops in other states; hence during the first month to six weeks of the shipping season there is practically no competition from other areas. Harvest in the earliest locations frequently begins in June, but most of the shipments are made during July and August from the Lake-Mendocino, the "river," and the Sierra Nevada foothills districts. Only limited supplies of Bartletts are shipped from the Napa and Santa Clara valleys. All the northern districts except the Sierra Nevada foothills provide some cannery stock, and a considerable tonnage in Lake and Santa Clara counties is dried. Practically the entire production of the southern district is disposed of on the fresh-fruit markets of southern California.

Production of the fall and winter varieties centers mainly in the Santa Clara Valley, in Santa Cruz, Monterey, and San Benito counties, and in the Sierra Nevada foothills. Most of the crop is shipped to eastern markets or exported, only limited supplies being used during recent years for canning and none for drying. Harvest usually begins during the latter part of September. Most of the crop, except possibly the Hardy (which is mainly exported), is held in cold storage and marketed during the winter and spring. Although these varieties mature too late to compete seriously with California Bartletts on the eastern markets, they encounter rather intense competition with pears from other states.

PLUMS

Although plums are grown over a widespread area of the state, approximtaely two thirds of the present commercial acreage centers in the Loomis-Auburn district of Placer County; in Sacramento, San

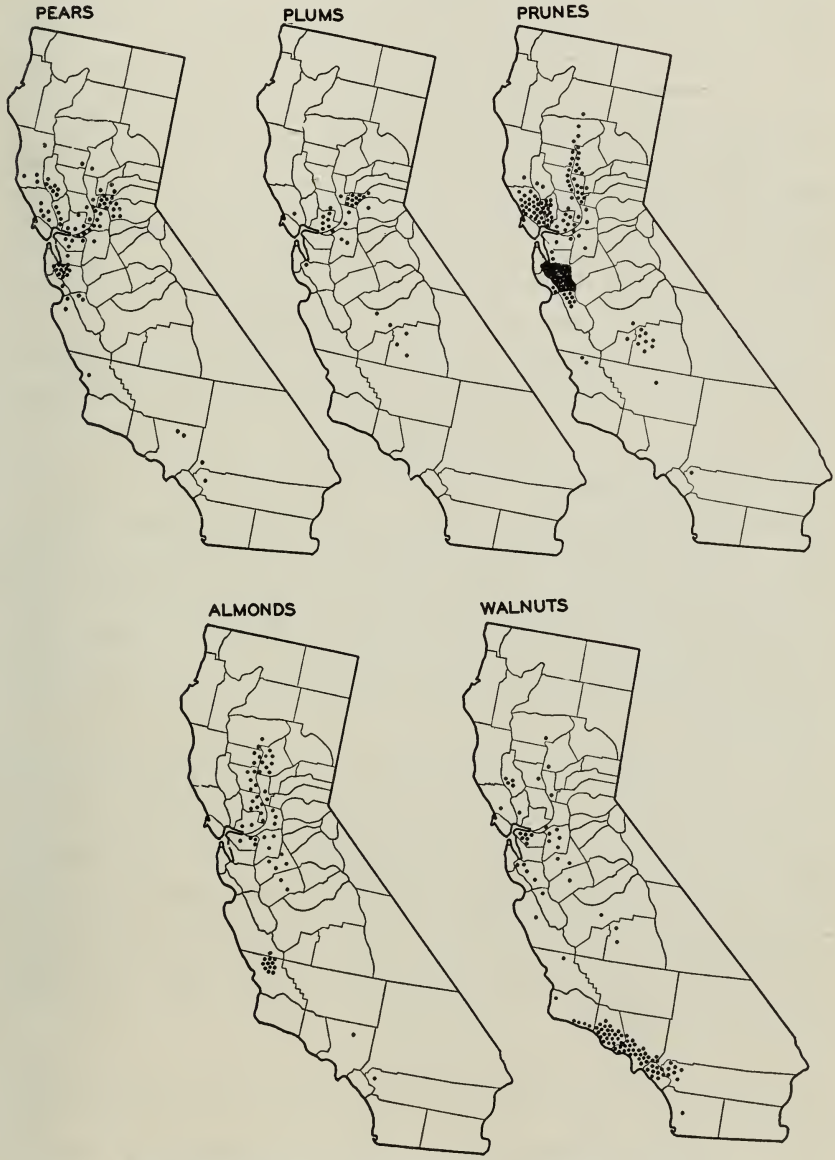

Fig. 18.—Distribution of pears, plums, prunes, almonds, and walnuts. One dot = 1,000 acres.

Joaquin, and Solano counties; and in Tulare, Kern, and Fresno counties (fig. 18).

The plums grown commercially in California are mainly of the European and Japanese types, with a few hybrids of the latter. Many varieties, each with somewhat distinctive characteristics, have been developed and are now grown rather extensively in the areas to which they are adapted, a fact that partially accounts for the widespread distribution of the acreage over the state. Specific varieties and, to some extent, types tend to be localized. The early-blooming habit of many varieties, particularly the Japanese, restricts their production to areas usually free from late spring frosts. Since, moreover, irrigation is necessary in most areas and highly desirable in all plum-growing sections, plantings are mainly restricted to irrigated sections. Plums prefer rather deep, well-drained loam or clay loam soils, but they are often found on relatively shallow or poor soils in areas where other conditions are favorable or where earliness of maturity commands a premium price.

Throughout the San Joaquin Valley and in the south, plantings are distributed rather widely, often in conjunction with other fruits in the same orchards. A wide range of environmental conditions prevails in these areas, with corresponding variations in yield, quality, date of maturity, and profitableness.

The heavy concentration of plums in the foothill sections of Placer County, in the Vacaville-Winters district of Solano and Yolo counties, and in the Arvin district of Kern County is largely attributable to the early maturity of the crops in these areas. Localities producing particularly early fruit tend to specialize in shipments to out-of-state markets, except in southern California, where the relatively small supply is consumed locally.

Most of the United States production of canned plums is grown and packed in California. During the ten-year period 1928-1937, however, the quantities canned annually have averaged only about 3.3 per cent of the harvested production. For canning purposes, the European type of plum is the most useful because the trade prefers the green or yellow varieties to those highly colored. As earliness is secondary in importance to yield, quality, and color, most of the canning stock is produced in the coastal valleys adjoining San Francisco Bay and in other areas where the crop matures late.

PRUNES

Prune production (fig. 18) is confined largely to the counties bordering San Francisco Bay, to the Sacramento Valley, and to Fresno and Tulare counties in the San Joaquin Valley. The greatest concentration occurs in the Santa Clara Valley, where the California industry had its

beginning. This valley, with the relatively small acreages in adjacent counties, contains well over 40 per cent of the total for the state. Second in importance is the area to the north of San Francisco Bay—about 27 per cent of the state acreage. Plantings here are confined mainly to the Russian River Valley, centering at Healdsburg in Sonoma County, and to the Napa Valley. Acreage in the Sacramento Valley—perhaps 20 per cent of the state total—occurs in rather small, discontinuous belts widely distributed. The Fresno-Tulare area, in the middle San Joaquin Valley, comprises only about 4 per cent of the present standing.

As may be judged from this distribution, the prune is adapted to a relatively broad range of environmental conditions. It thrives on a variety of soils, provided they are reasonably fertile and fairly deep. Although some orchards produce crops without irrigation, in practically all areas one or two irrigations during the growing season are required to produce fruit of good quality and large size. A long season of clear, warm weather is required to mature the crop, and freedom from fall rains is needed to dry the fruit. The use of dehydrators is gaining favor, particularly where there is danger of rains during harvest.

ALMONDS

Almond production, though widely distributed over the interior-valley areas (exclusive of the desert), centers mainly in the Sacramento and northern San Joaquin valleys and in the Paso Robles district of San Luis Obispo and Monterey counties. The Sacramento Valley contains approximately 50 per cent of the present bearing acreage. Plantings are concentrated in the Chico, Live-Oak—Yuba-City, and Fair Oaks districts on the east side of the Valley and in the Orland, Arbuckle, Esparto, and Winters districts on the west. The San Joaquin Valley acreage, approximately 22 per cent of the state total, is concentrated largely in the Oakley district of Contra Costa County, the Oakdale district of San Joaquin and Stanislaus counties, and the Atwater-Livingston district of Merced County. In the Paso Robles district, which contains about 27 per cent of the present bearing acreage, plantings occur in the valleys and on the rolling hill lands near the city of Paso Robles. Minor concentrations in Contra Costa and Riverside counties and scattered plantings elsewhere make up the remainder of the state acreage.

The almond is the first deciduous fruit to bloom in the spring and one of the last to drop its leaves in the fall. Successful culture, therefore, largely depends upon a long, warm growing season and particularly upon the absence of damaging frosts in the early spring. Although the tree is somewhat more drought-resistant than many others, its ability to produce successfully without water has been overestimated. To utilize

locations well suited to almonds climatically, many plantings have been made where soil or moisture conditions are unsuitable, with resultant low yields and unprofitable production. In areas which are well suited to almonds except for lack of soil moisture, yields may be increased one third to one half or more by irrigation. Because of the need for cross-pollination, three to five or more varieties are planted, in rows or blocks, within each orchard. Of the numerous varieties produced in California, the six leaders—Nonpareil, Drake, Texas, Ne Plus Ultra, I.X.L., and Peerless—make up slightly more than 90 per cent of the present total acreage.

Although almonds can be grown successfully over a great part of the state, the present distribution (fig. 18) represents some areas well adapted to almond culture and some poorly adapted. In the Paso Robles district and elsewhere, extensive plantings were made during the decade 1915–1924, mainly by real-estate promoters for subdivision purposes. Much of this acreage failed to produce as anticipated, principally because of poor soils, damaging frosts, and inadequate moisture. None of these conditions can be rectified. Since these tracts have proved unprofitable, part of the acreage has been given up, and more will probably be abandoned or uprooted in time.

Plantings, however, in tested areas, mainly in the Sacramento Valley, have partially offset this loss of acreage, and in 1938, a total of 89,565 acres of almonds was reported, of which approximately 80 per cent was of bearing age.

WALNUTS

California produces annually more than 90 per cent of the English (Persian) walnut crop of the United States. Most of this production is grown in the south-coast region, where approximately two thirds of the walnut acreage of California is concentrated. In this region, plantings extend from Santa Barbara through Ventura, Los Angeles, and Orange counties, and as far inland as western Riverside and San Bernardino counties. Less extensive plantings occur in the Walnut Creek section of Contra Costa County, in the Santa Clara Valley, in the Middleton, Kelseyville, and Calistoga districts of Lake and Napa counties, and in San Joaquin, Stanislaus, and Tulare counties.

Walnuts require a long growing season with moderately warm but not excessive summer temperatures. Freedom from late spring frosts is essential, since blooming occurs rather early and since both the tree and the crop are susceptible to damage during the spring. Excessive heat in the growing season sunburns the nuts. Some adjustment can be made to minor environmental differences: later-blooming varieties are selected for the northern areas because of the prevalence of spring frosts; varie-

ties least subject to sunburn are used in the warm interior valleys; and the more blight-resistant types are increasing in importance in the areas subject to this disease. But with these and other minor exceptions, the limits of successful culture are defined narrowly. Thus far, no varieties have been developed that will withstand the excessive heat and rapidly changing temperature of the desert region or of the warmer sections of the interior valley. The coastal areas in the central and northern regions lack sufficient heat to mature the crop and are subject to walnut blight, which thrives in a cool, moist climate.

In 1938 there were standing approximately 136,000 acres of English walnuts, of which 123,400 (or approximately 85 per cent) were of bearing age. Of the several varieties of walnuts produced in the state, the Placentia and similar types constitute about 41 per cent of the total acreage; Franquette, 12 per cent; Payne, 11 per cent; Eureka, 10 per cent; and seedling types about 9 per cent. Concord and miscellaneous varieties occupy the remainder of the total acreage.

Production during the period 1914–1933 increased at a fairly uniform rate of about 6.5 per cent a year, and the entire crop in most years moved into the hands of the trade at fairly profitable prices. As with many other specialty crops, the demand fell off markedly in the recent years of low purchasing power, and prices dropped precipitously to levels unprofitable for most growers. During the crop year 1932–33 the United States shifted from an import to a net-export position. With further increases in domestic production, prices to growers are unlikely to rebound soon to pre-Depression levels. Since 1933, plantings have continued, but at a declining rate; there has been some loss of bearing acreage in the south-coast region by the uprooting of trees in order to use the sites for citrus. Although some additional acreage may be uprooted, most of the trees will probably be maintained for a considerable time because of the large fixed investment and the cost of shifting to other enterprises.

Black walnuts are produced in limited quantities in most of the walnut-producing areas of the state. Part of the production comes from border plantings around orchards or from shade trees along roads and driveways, the remainder from plantings in orchard position. Of the 4,750 acres of black walnuts in orchards in 1936, approximately 55 per cent was in Lake, Santa Clara, Contra Costa, and San Benito counties. An additional 15 per cent was in San Joaquin, Merced, and Stanislaus counties, and the rest was widely distributed over the central and southern parts of the state.

Part of this acreage is, in reality, potential English-walnut acreage. As the black-walnut root is preferred for orchards, seedling black trees are often planted in orchard position, to be top-grafted later to English

walnuts. The acreage to be thus utilized cannot be foretold, for practice varies considerably according to the age or size at which the top-working is done. The actual and potential black-walnut acreage, however, is undoubtedly less than the total reported for 1936.

GEOGRAPHIC DISTRIBUTION OF GRAPES

The cultivated grapes of California are practically all of the vinifera type (*Vitis vinifera*) originally imported from the countries bordering the Mediterranean. This is often called the European grape, as distinguished from the American species grown in other parts of the United States. The vinifera type, being indigenous to semiarid subtropical regions, will not thrive in humid climates nor withstand intense winter cold. Its essential requirements are hot, arid summers, cool, wet winters or irrigation facilities to supplement rainfall, and freedom from unseasonable frosts. Grape production, as shown in figure 19, is confined mainly, but not entirely, to irrigated sections of the interior valleys and to the warmer sections of the coastal regions where plantings, both in the valleys and on the slopes, are grown mainly without irrigation. The widespread planting of grapes throughout the warmer sections is partly attributable to the large number of varieties, each of which has a somewhat different range of adaptation to environment and of uses for the product.

The grapes produced in California may be classified, according to use, into three types: raisin, table, and wine. Each variety is generally better suited to one of these uses, some exclusively so, but a few are suitable for more than one purpose. For example, the leading black varieties of wine grapes—Zinfandel, Alicante Bouschet, Mission, Carignane, Mataro, and Petite Sirah—are utilized exclusively for juice stock. The Tokay (Flame Tokay), Emperor, and Cornichon (Olivette Noire) serve almost exclusively as table grapes. The Malaga is used as a table grape, for wine, and in some years for raisins. The Muscat of Alexandria is used for making both raisins and wine and locally as a table grape, and the Thompson Seedless (Sultanina)—the leading table and the principal raisin variety—is regularly used also in wine making. The geographical distribution of acreages of the three types—raisin, table, and wine grapes—is shown in figure 19.

RAISIN

Raisin production is mainly confined to the San Joaquin Valley, centering in Fresno and Tulare counties. The large bodies of irrigated land, the long, warm growing season, the arid atmospheric conditions during the summer growing season, and the freedom from fall rains provide ideal conditions for growing and sun-drying the grapes. As there is no

price advantage in producing early or late raisins, production is mainly restricted to areas where large yields of high-quality fruit will mature several weeks before there is much danger of rain. In parts of the Sacramento Valley, growing conditions are equally satisfactory, but, because of more frequent and earlier fall rains, special methods involving the use of dipping solutions or dehydrators must be relied upon to hasten the drying. The additional labor and expense of producing raisins by

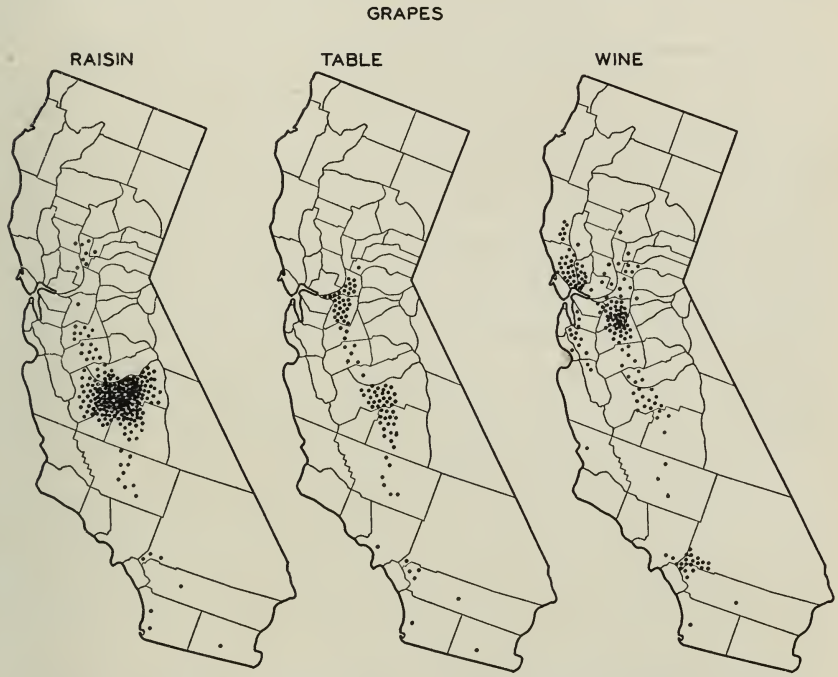

Fig. 19.—Distribution of raisin, table, and wine grapes. One dot = 1,000 acres.

these methods and the danger to the crop during harvest render this region less suitable than the central San Joaquin Valley. For these reasons and because of relatively low prices during recent years, the acreage of raisin varieties in this region has declined greatly.

In southern California, relatively few raisins are produced because grapes mature so early there that it is usually more profitable to harvest the crop for the fresh-market trade.

TABLE

Table grapes are produced mainly in the interior valleys, but because of the larger number of varieties grown, the acreage is distributed somewhat more widely than for the raisin types. Seasonality of maturity, attractiveness of appearance, eating quality, and ability to stand shipment

and storage are important factors in determining the marketability of table grapes. Each variety excels in one or more of these qualities, under somewhat different environmental conditions—a fact that partly accounts for the wider distribution of acreages of this type.

Of the four principal table grapes, the Malaga has the widest range of adaptation, but since it excels only in the hotter sections, the heaviest concentration occurs in the middle and southern San Joaquin Valley. Thompson Seedless production likewise centers in the middle part of the valley. Tokay grapes are grown principally in the Lodi section of San Joaquin County, directly east of San Francisco Bay, for here the berry attains not only a high sugar content but the deep-red color that is most in demand. The principal Emperor-producing section borders the foothills on the east side of the San Joaquin Valley in Fresno and Tulare counties. In this area the berry attains a light, purplish red that is considered preferable to the darker color produced in other areas. Several varieties of less importance are grown in selected areas throughout the Great Valley and in the Sierra Nevada foothills where soil and moisture are suitable. In southern California, table-grape production is a relatively minor enterprise. Plantings, mainly of Thompson Seedless and Malagas, center around the junction of Los Angeles, Riverside, and San Bernardino counties, with smaller acreages in San Diego County and in the Coachella and Imperial valleys (fig. 19).

The desert region produces the earliest table grapes grown in the state, harvested in June and July for local markets and eastern shipment, followed shortly by the early crop in Kern County. Harvest in other areas (due exception being made for varietal differences) proceeds generally from south to north and thus provides continuous supplies and a volume of shipments from July through November of each year.

WINE

Wine grapes are grown over a wider area than are either raisin or table grapes (fig. 19), some, in fact, being produced in nearly all grape-growing districts. This widespread distribution of acreage is attributable not only to the large number of varieties grown, but also to the demand for grapes of distinctive color, flavor, sweetness, and acidity for making wines of various types. Red wines require a highly colored skin; dry wines, high acidity and moderate sugar content; sweet wines, high sugar content and low acidity. Certain wines, such as Riesling type and Semillon, require special flavors, and the vintage of certain wineries attains pre-eminence by virtue of the distinctive character of grapes grown in selected areas. Thus, there is a demand for such grapes as can be produced only under different combinations of soil and climate.

The north-coast region, climatically ill-adapted to raisin- or table-grape production, produces excellent grapes for dry wine. Vineyards are located mainly in the Russian River valleys from Calpella in Mendocino to Sebastopol in Sonoma County, in the valleys abutting on San Francisco Bay and in the Livermore Valley of Alameda County. Plantings in these areas mainly occupy the benchlands and hillside slopes bordering the valleys where the vines are grown without irrigation. The principal varieties grown in the coast regions are, in their approximate order of importance: the Zinfandel, Carignane, Petite Sirah, and Alicante Bouschet, with smaller acreages of the Mataro, Mission, Grenache, Cabernet Sauvignon and some white dry-wine types.

Wine-grape acreages are distributed widely over the Great Valley, with heaviest concentrations in San Joaquin County and the adjoining counties of Stanislaus, Sacramento, and Placer. Important acreages are found also in the counties to the south, but much of the grape acreage in Fresno, Tulare, and Kern counties is made up of raisin and table types. In the nine counties to the north, occupying the floor of the Sacramento Valley, grape production has not attained such importance as in the San Joaquin.

Because of the warmer climatic conditions in the interior, grapes attain a higher sugar content and lower acidity there than in the cooler atmospheric conditions of the coast counties. These grapes are accordingly best adapted to the production of sweet wines. Dark-wine types predominate in the Sacramento and northern San Joaquin valleys, whereas in the middle and southern San Joaquin the Malaga, Muscat of Alexandria, and other white-wine types become increasingly important.

In southern California, wine grapes predominate in all but the desert region, where only table grapes are produced. Wine-grape production centers in western San Bernardino County, which, together with the almost contiguous areas in Los Angeles and Riverside counties and the smaller acreages in San Diego County, comprise almost the entire acreage of wine varieties and about two thirds of the total acres in vineyards in this region. Because of deficiency in rainfall, most of the vineyards in the southern areas are irrigated. Several varieties are grown, especially the Zinfandel, Alicante Bouschet, Mataro, Mission, and Muscat of Alexandria.

GEOGRAPHIC DISTRIBUTION OF SUBTROPICAL FRUITS

The subtropical-fruit group includes avocados, citrus (lemons, limes, oranges, grapefruit, tangerines), dates, loquats, olives, persimmons, pomegranates, and miscellaneous subtropical-tree fruits of negligible importance.

The areas within which these fruits, except olives, are grown are relatively small and are confined almost exclusively to the south-coast and southern interior-valley areas, to irrigated sections of the desert, and to the east side of the southern San Joaquin Valley (fig. 20). Minor acreages of citrus fruits and persimmons are found in the Sacramento Valley in Butte, Glenn, Sacramento, and Sutter counties. Olives, being somewhat hardier and more adaptable, are grown over a much wider area of the interior valleys.

These several areas have in common, conditions prerequisite to the successful culture of subtropical crops—namely, long, warm or hot summers, which provide the necessary thermal units for maturing the fruit, and relatively mild winters. Occasional minimum temperatures of 32° F or lower may occur, but usually for short periods only. Wherever the hazard warrants, orchard heating is practiced in an attempt to prevent crop losses and tree damage from unseasonable low temperatures. As the rainfall in these areas is either insufficient or inadequately distributed for the needs of these crops, irrigation is essential. Except with dates, for which absence of precipitation is necessary while the fruit is ripening, rainfall is not a controlling factor.

Fig. 20.—Distribution of subtropical fruits.

Within the areas generally adapted to subtropical fruits, local differences in elevation, topography, and proximity to the seacoast produce minor differences in climatic conditions that favor one type or variety over others. Thus, lemons and avocados (fig. 21) tend to be concentrated in the coastal areas, navel oranges in the southern interior and San Joaquin valleys, Valencia oranges in a somewhat intermediate position. Grapefruit production is largely confined to the desert region and to the interior valleys, with only minor acreages in the coastal areas. To some extent, therefore, these crops tend to be localized in one area or another, but the lines of demarcation are not all distinct, for gradual changes of type occur as one set of optimum conditions for growth grades into the next.

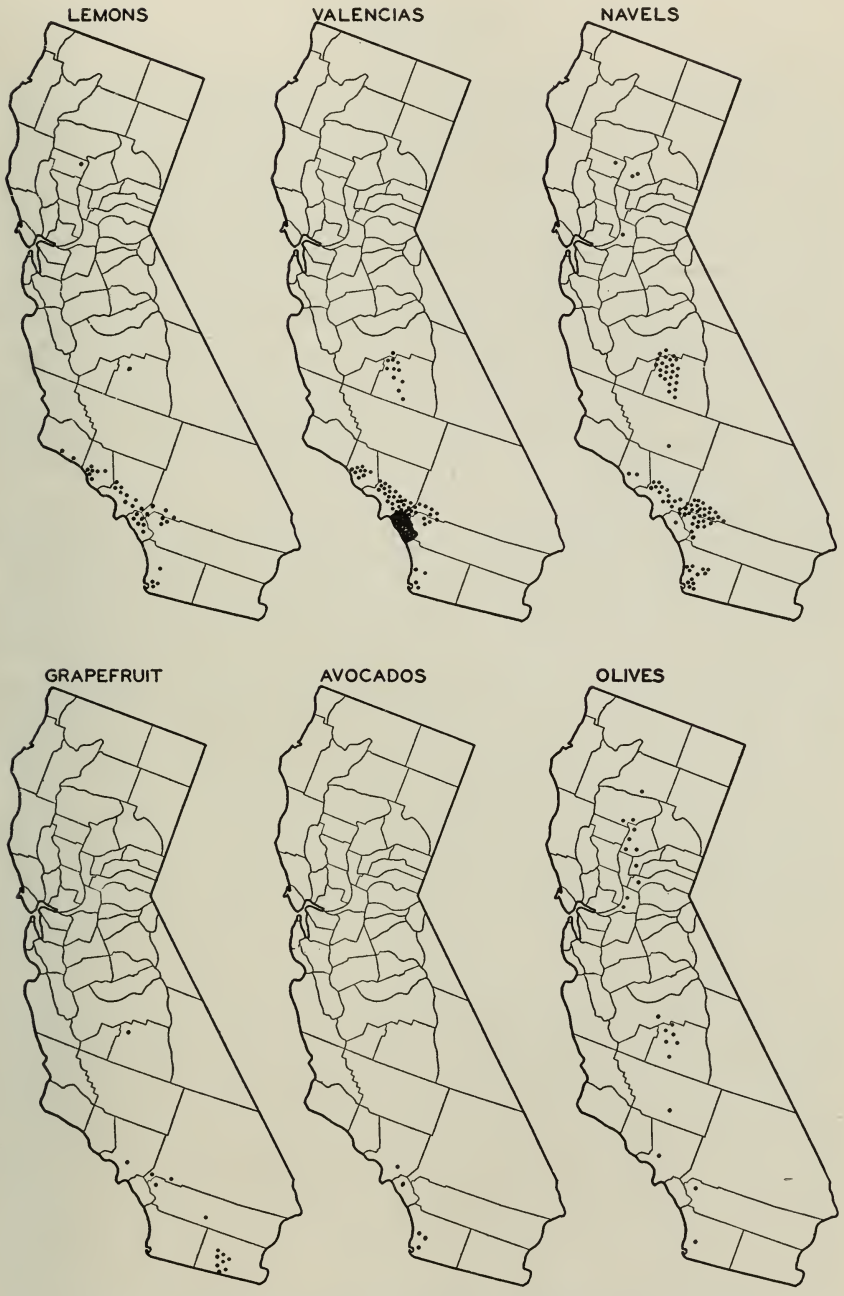

Fig. 21.—Distribution of lemons, Valencia and navel oranges, grapefruit, avocados, and olives. One dot = 1,000 acres.

AVOCADOS

Avocados are grown commercially only in the southern coastal region. More than 90 per cent of the present bearing and nonbearing acreage is in San Diego, Los Angeles, and Orange counties (fig. 21). Avocados are the most sensitive of the major subtropical fruits to frosts, to extremes of heat, and to aridity; hence plantings are usually located in frost-free belts within 30 miles of the coast where the atmospheric conditions are tempered by mild sea breezes. Rainfall is not a controlling factor in localizing plantings, for precipitation in this region is insufficient and must be supplemented by irrigation. The avocado is not highly selective in its soil preference; it thrives on any moderately fertile soil that is well drained. The trees are, however, particularly sensitive to both drought and excessive soil moisture so that adequate irrigation and drainage are essential.

There are three types or horticultural races of avocados—West Indian, Guatemalan, and Mexican. At present more than two hundred varieties of the Mexican and Guatemalan types are grown in California. Many of these, being inferior in both the quantity and the quality of fruit produced, are gradually being displaced by improved strains of tested varieties, of which the Fuerte is at present the most favored. Next of commercial importance are Nabal, Dickinson, Puebla, and Anaheim. A number of other varieties under test show some promise of superiority and in time may displace some of the present leading varieties.

Before 1921, California avocados were sold mainly on local markets and frequently brought the growers $0.60 to $1.00 a pound. Interest was stimulated by these attractive prices, and the industry expanded from 690 acres in bearing in 1927 to approximately 12,500 bearing and 2,000 nonbearing acres in 1938. Naturally, prices began to decline, and leaders in the industry early recognized that profitable returns could, in the future, be maintained only by expanding market outlets and stimulating demand. In 1924 the California Avocado Growers Exchange, later renamed the Calavo Growers of California, was organized. Largely through its activities the demand was greatly increased, though not enough to offset entirely the effect of the rapidly increasing supplies and of the decline in general purchasing power since 1929. With the return to more normal business conditions, some further extension of markets and stimulation of demand may reasonably be expected. Nevertheless, as development and operating costs are relatively high, one may question whether the price can be maintained at a sufficient level to warrant further large increases in production or even to permit the profitable operation of many of the present groves.

GRAPEFRUIT

Grapefruit requires more heat than any other of the subtropical fruits grown in California except dates. For this reason the largest concentration (fig. 21) is found in the desert, mainly in the Imperial Valley and to a lesser extent in the Coachella Valley. Next in acreage and production are the interior valleys of Los Angeles and western San Bernardino and Riverside counties. Minor acreages occur in the subtropical-fruit belts of the Great Valley and in the warmer sections of the coastal areas of Los Angeles, Orange, Ventura, and San Diego counties.

The desert grapefruit is a distinctive and superior product as compared with that produced in other areas of the state. It is harvested and shipped mainly from October to May. Shipments from the San Joaquin Valley are made mainly in April and May; from the southern interior valleys, from May to September. In the coastal areas the crop matures during the late summer, when competition from other producing centers is at a minimum. Despite the competition with other fruits, the small supplies of summer grapefruit available during this period have commanded relatively high prices, sometimes returning almost fabulous incomes.

California thus ships grapefruit throughout the year. The desert produce and that shipped from other areas between October and May encounter intense competition on eastern markets with supplies from other states. The competition from June to September is much less severe, giving rise to the higher level of prices obtained during the summer. Of late years, however, an increase in the volume of grapefruit canned has, in part, extended the marketing period for competing areas, and this may eventually lower the price advantage enjoyed by California growers of summer grapefruit.

LEMONS

Over 95 per cent of the present acreage of lemons is located in the seven southern counties of Ventura, Los Angeles, Orange, San Diego, Santa Barbara, San Bernardino, and Riverside, listed in the order of their importance. Minor acreages occur in the citrus belts of Tulare and Fresno counties in the San Joaquin Valley and in Colusa County in the Sacramento Valley. Lemons require less heat than the other citrus fruits and do not readily withstand the extremes of temperature in the interior valley. They thrive in the cooler and more equable climate of the coastal area of southern California where in selected locations large yields and fruit of high acid content are obtained. Because of its evergreen nature and its continual fruiting habit, the tree is highly susceptible to frost damage. Successful culture, therefore, depends in part upon the selection

of frost-free sites or at least of areas where damage can be prevented or minimized by the use of orchard heaters.

The California lemon industry is based principally upon two varieties, the Eureka and the Lisbon, with only minor acreages of Villa Franca and other varieties. The Eureka is by far the most popular variety in all producing sections, primarily because of its productivity and its fruiting habit which matures a large part of its crop in the spring and summer months when demand is most brisk and prices are generally highest. In spite of somewhat greater vigor, hardiness, and a wider range of adaptability to environmental conditions, the Lisbon lemon has not attained the popularity of the Eureka, primarily because its peak production is from January to May; hence it is considered a winter producer, or one-crop variety. These tree characteristics are the principal distinguishing features of the different varieties, since the fruit is almost identical and can scarcely be differentiated when mixed. The fruit of all varieties is generally marketed without varietal segregation, the crop being known and acceptable to the trade simply as California lemons.

The United States production of lemons centers in California. Shipments by rail and boat are made throughout the year from crops maturing at different times in the several producing areas and from storage. Most of the total, however, is shipped during the summer.

ORANGES

The principal varieties of oranges grown in California are the Valencia and the Washington Navel. At present about 93 per cent of the acreage and 98 per cent of the total orange shipments are of these two varieties. The remainder of the acreage and production is made up of various seedling types and such varieties as Mediterranean Sweets, Maltas, Bloods, St. Michaels, and tangerines. In acreage, the Valencia exceeds the Washington Navel. In 1936, according to the California Coöperative Crop Reporting Service, there were 126,460 bearing and 16,940 nonbearing acres of Valencias and 82,370 bearing and 6,170 nonbearing acres of Washington Navels. Although both varieties are grown, to some extent, in the same general localities, there is a noticeable difference in the proportionate amounts of them in different climatic zones, largely because of differences in fruiting habit and because of the somewhat different range in adaptation to climatic conditions for each variety.

The Washington Navel orange is more tolerant of high summer temperatures and less susceptible to frost during the winter months than the Valencia; hence, it is better adapted to the climatic conditions in the more interior sections of the south-coast region and in the Great Valley, where the greatest concentrations of this variety are to be found.

The Valencia is highly susceptible to frost damage because the tree blossoms during the winter. In addition, high summer temperatures tend to puff and green the fruit as it approaches maturity. This variety prefers, accordingly, the moderate and more equable climate of the coastal areas, and it is here that the greatest concentration occurs.

The harvesting and shipping period for Washington Navels in California normally extends from November to May; for Valencias, from April to November. Thus, though supplies of oranges from California are available throughout the year, neither crop seriously competes with the other. The Washington Navel, however, is marketed in direct competition with Florida oranges, whereas the Valencia is shipped at a time when only limited supplies of oranges are coming from other areas. Other fruits available in abundance during the summer do, however, seriously compete with Valencia oranges.

OLIVES

Olive and olive-oil production in the United States is virtually confined to the Sacramento Valley, the San Joaquin Valley, and the south-coast region of California (fig. 21), which contained approximately 40, 38, and 17 per cent, respectively, of the 25,227 bearing acres and 740 nonbearing acres reported in 1936.

In the Sacramento Valley, plantings are concentrated near Oroville in Butte County, Corning in Tehama County, and Fair Oaks in Sacramento County. In the San Joaquin Valley, production centers in the Lindsay-Exeter district of Tulare County, with minor acreages in the adjoining counties of Fresno, Madera, and Kern. In the south the present acreage occurs in widely separated areas throughout the warmer sections of Los Angeles and San Diego counties and in the western Riverside and San Bernardino counties. In this region and in the San Joaquin Valley the olive is used frequently as a border planting around citrus and deciduous-fruit orchards, serving admirably as a windbreak, a dust screen, and an ornamental border.

The olive requires a frost-free period from about April to December and will withstand considerable heat and aridity during the growing season. Although relatively hardy, the tree is subject to damage by freezing temperatures during the winter. The tree is adapted to a wide range of soil types and will grow on soils too poor for the successful culture of other tree crops. Contrary to common opinion, however, the olive does not prefer shallow or poor soils; it grows more vigorously and produces greater yields on good land. In most areas, irrigation is essential to assure good yields and high quality.

The climatic requirements of the olive and its adaptation to soils of

varying character largely account for the concentrations of plantings on the foothill stretches bordering the eastern side of the Sacramento Valley and in the southern San Joaquin Valley. Although many areas in the southern part of the state are suitable for olive production, the greater returns obtained in the past from citrus fruits and walnuts have relegated olives to a place of minor importance.

Because of the relatively unfavorable price situation during the past decade little additional acreage has been planted; hence, a large part of the present acreage is now in bearing. Since 1928 there has been an actual decrease of about 15 per cent in bearing acreage. Production has continued to increase, however, because of the greater percentage of the total acreage in full bearing. California produces about 99 per cent of the olives grown in the United States. Of this crop, in recent years, approximately 58 per cent has been canned, 36 per cent crushed for oil, and the remainder (about 6 per cent) dried or shipped fresh to eastern markets. The principal varieties are, in approximate order of importance, the Mission, Manzanillo, Sevillano, Ascolano, and Barouni.

MISCELLANEOUS SUBTROPICAL FRUITS

Numerous other subtropical fruits of various types are produced in relatively small amounts throughout the citrus areas of southern California and the thermal belts of the Great Valley. Of this group, dates and persimmons are probably most important in acreage and in value of product, and they represent the extremes in range of adaptation to environment.[21]

Conditions under which the date thrives are the most narrowly circumscribed in this group. It requires high summer temperatures, an arid growing season, and freedom from rains during the ripening period. The date palm is adapted to various soil types provided they are deep and well drained. It consumes water voraciously, requiring, in areas where it is now grown, from 6 to 10 acre-feet annually, applied in frequent irrigations throughout the year. Most of the plantings, totaling 3,588 acres in 1936, are located in the Coachella and Imperial valleys. Only a few of minor importance are scattered elsewhere. Approximately one half of this acreage was reported as of bearing age. Of the several types and many varieties of dates grown experimentally by individuals and by the United States Department of Agriculture, the Deglet Noor has proved most adaptable and is now commercially most important.

The consuming public has not yet been educated to the excellence of fresh dates nor to the superiority of the American product to the proc-

[21] Citrons, cherimoyas, guavas, jujubes, kumquats, loquats, mangos, papayas, passion fruit, pomegranates, quinces, and sapotes, occupying a total of approximately 1,400 acres, constitute the other fruits in this group.

essed bulk and package dates imported from foreign countries. Limited supplies of excellent fresh and semifresh dates command prices high enough to offset the high costs of producing and marketing, but beyond this point the domestic product is forced into direct competition with the inferior but cheap imported pack. Although the desert region provides a large potential date-producing area, the industry has not attained great importance, mainly because of the high cost of establishing and operating the gardens and because of the limited market demand for dates of high quality.

Persimmon production in California consists almost entirely of the Japanese type, of which the Hachiya is at present preferred. Plantings are to be found over a widespread area of the state, from Shasta County on the north to San Diego County on the south. Approximately half of the total acreage, however, is in the four coastal counties of Los Angeles, Orange, San Diego, and Ventura. The persimmon thrives under conditions favorable for citrus production, but it is somewhat more adaptable, withstanding colder exposures and somewhat higher temperatures than either the orange or the lemon. Individual plantings are typically small, ranging from a few trees to a few acres, and are grown frequently in conjunction with citrus or deciduous-fruit orchards.

Persimmon plantings expanded rapidly during the decade ending in 1932, in that year reaching the peak of 2,213 acres of bearing and 584 acres of nonbearing trees. Although the fruit matures late in the season and is available fresh for the holiday trade, it is not well known to the American public, and the market is decidedly limited. With the rapidly increasing supplies of recent years came a price decline to unprofitable levels, which resulted in the uprooting of some orchards and the cessation of plantings. By 1936 the acreage had diminished to only 1,560 acres, of which 94 per cent was of bearing age in that year.

CROP DISTRIBUTIONS BY REGIONS

Comparison of the maps showing the distribution of crop acreages of the various enterprises (figs. 9–21) indicates marked differences in their concentration in various parts of the state. Summarized on a regional basis, figure 22 shows the distribution of crops, irrigated and nonirrigated, expressed in percentage of the total harvested crop acreage as of 1929.

For the entire state, small grains and hay other than alfalfa amounted to about 44 per cent of the harvested crop acreage. Alfalfa, row crops, and deciduous fruits each occupied about 12 per cent; grapes, about 8 per cent; cotton, subtropical fruits, large grains, and rice combined, somewhat less than 12 per cent.

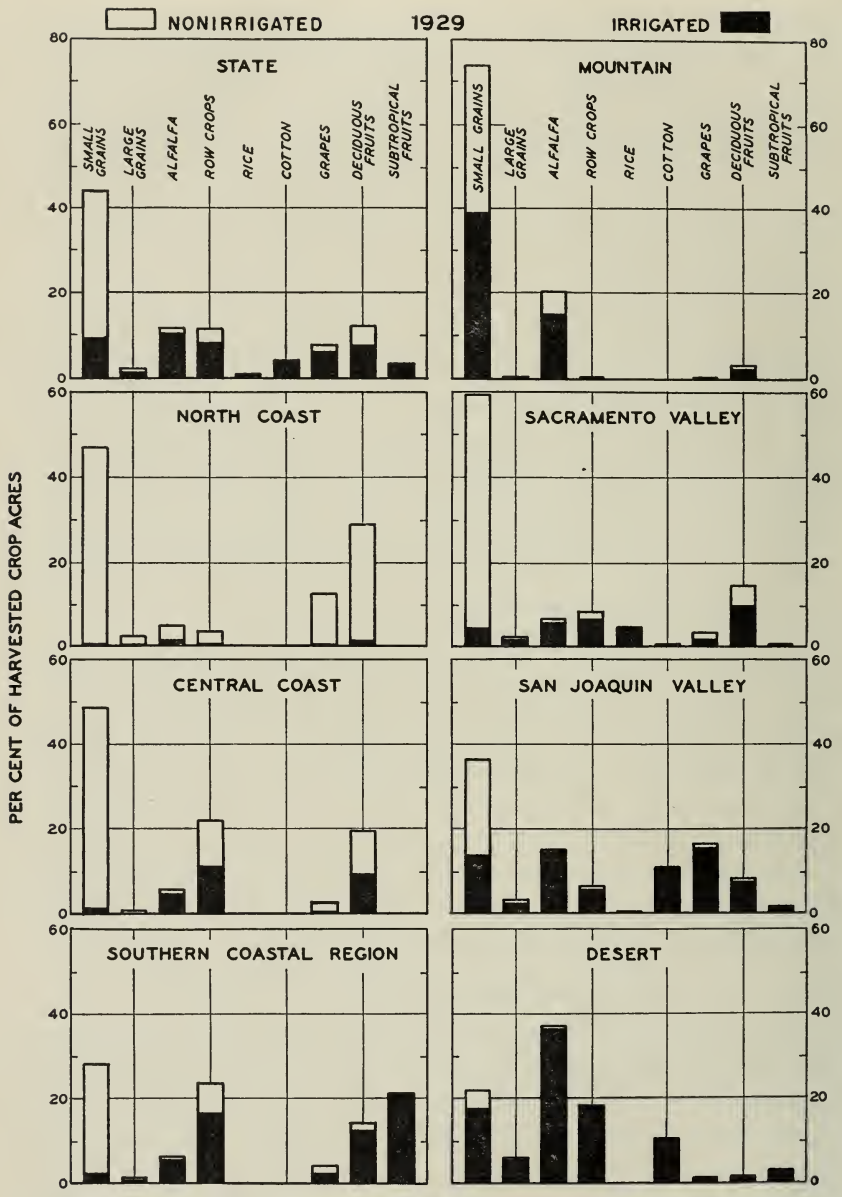

Fig. 22.—Distribution of crops, irrigated and nonirrigated in per cent of total harvested crop acreage for the state and by regions, 1929. Small grains also include hay other than alfalfa. (Data from tables 2 and 3.)

Small grains and nonleguminous hays are the dominant types of crop, in point of acreage, for the state and for all regions except the desert. These commodities are produced mainly under dry-farming conditions in all but the desert regions. Dependence upon irrigation for the production of all other types of commodities everywhere except on the north coast is evident. Figure 22 also depicts the increasing importance of irrigation in the production of all crops with the decrease in rainfall from north to south.

On the basis of gross value or even of net value over a period of years, the relative importance of the various types of crops would be markedly different from that shown by acreage comparisons. Such intensively cultivated and irrigated crops as deciduous fruits, row crops, and subtropical fruits would increase in importance, whereas such extensively cultivated crops as alfalfa and the large and small grains would decrease in importance on a gross-income basis as compared with that shown on the acreage basis. The change in relative importance of a given type of crop from region to region would be, however, about the same on either basis.

The mountain region is more highly specialized than any other large area in the state. It is given over mainly to a range type of agriculture and to the crops used for hay (natural grasses, small grains, and alfalfa) to feed the livestock of this region. The commercial production of deciduous fruits, principally apples and pears, is confined to small discontinuous areas along the foothills and in the mountain valleys.

In contrast to this region, a great diversity of crops is produced in the Great Valley, particularly in the San Joaquin portion, or even the desert (fig. 22). In these regions, as well as in the south coast, a vast array of temperate zone and subtropical fruits, field, and row crops is produced, largely under irrigation. The proportion of the cropland used for each type of enterprise, however, differs markedly. Thus, in the Sacramento Valley nearly 60 per cent of the harvested crop acreage is used for small grains, about 15 per cent for deciduous fruits, and somewhat more than 8 per cent for row crops. In the San Joaquin Valley, on the other hand, the small grains and the deciduous fruits, occupying about 37 per cent and 8 per cent, respectively, of the harvested acreage, decline in relative importance, whereas alfalfa, cotton, and grapes increase.

The desert region is distinctive in that alfalfa, which occupies 37 per cent of the harvested cropland, exceeds in acreage all other types of crops, including the small grains and hay. This latter group, though second in importance to alfalfa, occupies only 22 per cent of the crop area. Row crops, cotton, the large grains, and subtropical fruits, take up 18.6, 10.7, 6.0, and 3.0 per cent, respectively.

In the north-coast region the principal product on an acreage basis is small-grain hay, raised mainly as feed for the beef cattle, dairy cattle, and sheep. In comparison with other crops, however, deciduous fruits are more important in this region than in any other area. Grapes are also a major crop.

In the central-coast region the small grains predominate also, but more of this crop is harvested and marketed as grain and relatively less is fed to livestock than in the north coast. In this region, furthermore, grapes are relatively unimportant, deciduous fruits are relatively less important, and row crops are absolutely and relatively of much greater importance than in the north coast.

The south coast differs from the other coastal regions in that relative to other crops, only about half as much small grain is grown, deciduous fruits are relatively minor, whereas subtropical fruits and row crops attain a major importance. Only in this region, indeed, do subtropical fruits become a principal industry. All other subtropical-fruit areas are insignificant, on an acreage basis, relative to other types of crops grown in the same region.

GEOGRAPHIC DISTRIBUTION OF LIVESTOCK ENTERPRISES

The three major characteristics of California agriculture—namely, diversity in types of production, specialization by individual operators, and interspersion of different types within areas—apply to livestock as well as to crops. Nearly all types of domestic livestock are raised, the numbers and proportions varying in different parts of the state in accordance with the differences in environment and the conditions of production. From time to time, of course, the numbers and proportions of different classes of livestock shift somewhat because of changes in price relations; but in recent decades the types of livestock associated with specific environments have not changed appreciably. Particularly is this true of beef cattle and sheep, which, because of special feeding habits and requirements, utilize to best advantage different types of range.

In the selection of forage, cattle are generally more exacting than sheep or goats. They prefer the grasses and consume only a small proportion of weeds and browse, since relatively few species of these plants are palatable to them. For them, grazing conditions are best when much cured grass is available. Usually, however, they seek some variety in their feed, browsing somewhat on shrubs even when grass and palatable weeds are abundant.

Sheep, on the other hand, graze very little on cured or on rank growth of grass, preferring the tender green foliage of grasses and weeds and

the grains of many grasses. On the whole, they relish weeds much more than cattle do, and they will eat parts or all of most weed species on a closely grazed range. In addition, they tend to browse more extensively and less discriminatingly than cattle do.

Goats are primarily browsing animals, yet they graze to a considerable extent when grazing conditions are good. Like sheep, they prefer succulent weeds and grass and, in the absence of such growth, do little or no grazing. In browsing they show a variety of selection not approached by either cattle or sheep, and they are the only domestic foraging animals that do well on California chaparral.

Over a period of years, therefore, on ranges where grasses distinctly predominate and where the topography is not oversteep, cattle will utilize the plant cover to best advantage. On a mixed cover of grass, weed, and browse, sheep are best suited; and on areas predominantly browse, goats will insure the most complete utilization of the range.

Nature of the Range.[22]—In different parts of the state there are marked differences in the nature of the range and in its use as breeding grounds and finishing areas. Some land is so barren or so heavily covered with forest or brush that there is no forage for livestock. Much of the noncultivated area affords only light grazing and relatively little of it ideal pasture. Plate 1, showing the plant cover, indicates only the dominant types of vegetation broadly defined as desert, brush, forest, and grass. This map does not adequately present the types of vegetation suitable for grazing. Aside from the grass areas, the range livestock utilize many plant species that partly make up the cover and undercover in the other areas.

Broadly considered, the range types occur in four life zones, or belts of vegetation (fig. 23)—Lower Sonoran, Upper Sonoran, Transition, and Boreal. A profile showing these life zones and the characteristic plants found at various altitudes on the ranges of California is presented in figure 24.

The Lower Sonoran zone, extending from below sea level to 5,000 feet in elevation, comprises about 36.5 per cent of the state and is composed of two somewhat distinct areas—the Great Valley of California and the Colorado and Mojave deserts. The desert areas are characterized by annual rainfall of less than 5 inches, moderate to low winter temperature, high summer temperature, low humidity, and occasional desiccating winds. The vegetation is rather low of stature, widely spaced, with forage species that are succulent and highly palatable only during the short,

[22] This section, prepared by A. W. Sampson, Professor of Forestry and Plant Ecologist in the Experiment Station, is a revision of data appearing in: Voorhies, E. C., and A. B. Kroughan. Economic aspects of the beef cattle industry. California Agr. Exp. Sta. Bul. 461:33–40. 1928. (Out of print.)

active growing season (fig. 24). A goodly proportion of the green-leaved evergreens and fleshy-stemmed plants have practically no food value for stock. In somewhat protected places a few annual grasses and a lesser number of perennial grass species occur. Occasionally chenopods and

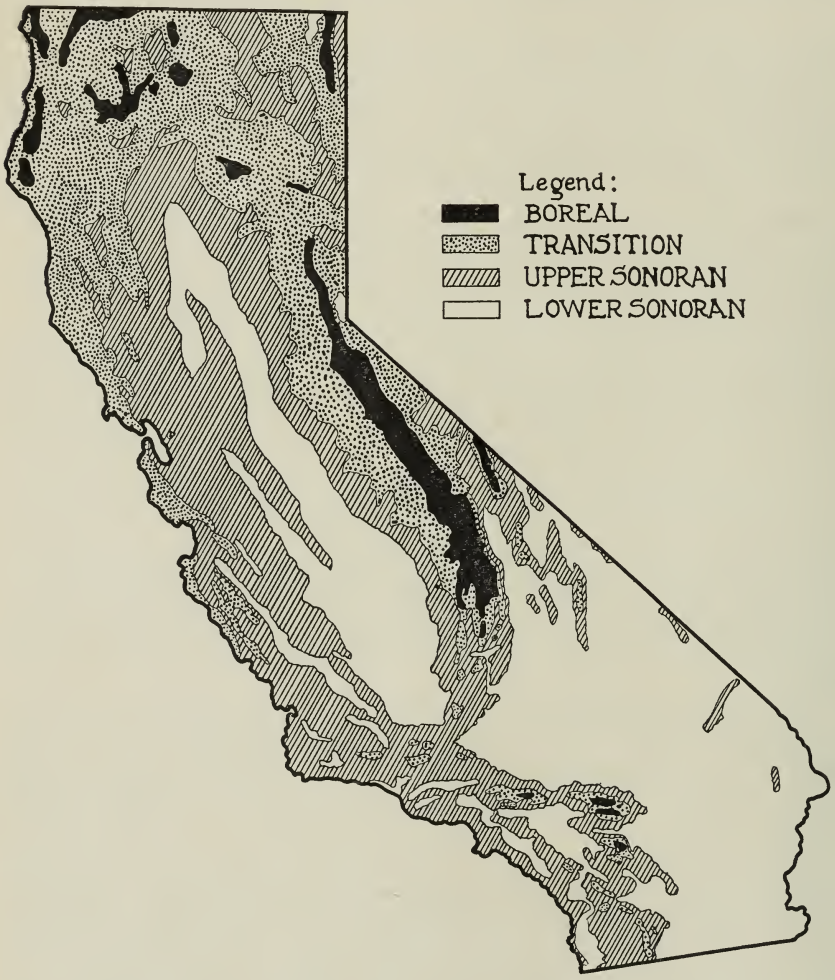

Fig. 23.—Range types of California according to life zones. The Boreal zone comprises about 4.5 per cent of the total area of the state, the Transition zone 26.0 per cent, the Upper Sonoran zone 33.0 per cent, and the Lower Sonoran zone about 26.5 per cent. (After Jos. Grinnell; from Bul. 461.)

saltbushes occur in sufficient abundance to afford a valuable cattle browse feed. The few species of trees indigenous to this zone are confined to stream beds and low-lying moist areas where they serve as shelter for livestock during inclement weather. The grazing capacity is lower than

in any other zone; for there are vast areas which, because of extremely sparse vegetation and scarcity of water, are totally unsuited to grazing at any time of the year.

The Lower Sonoran zone extends over most of the Great Valley between the 10- and 500-foot elevations and is largely grassland. Here the vegetation is more abundant and succulent than in the desert and much better suited to stock grazing. The tree growth, confined to moist areas,

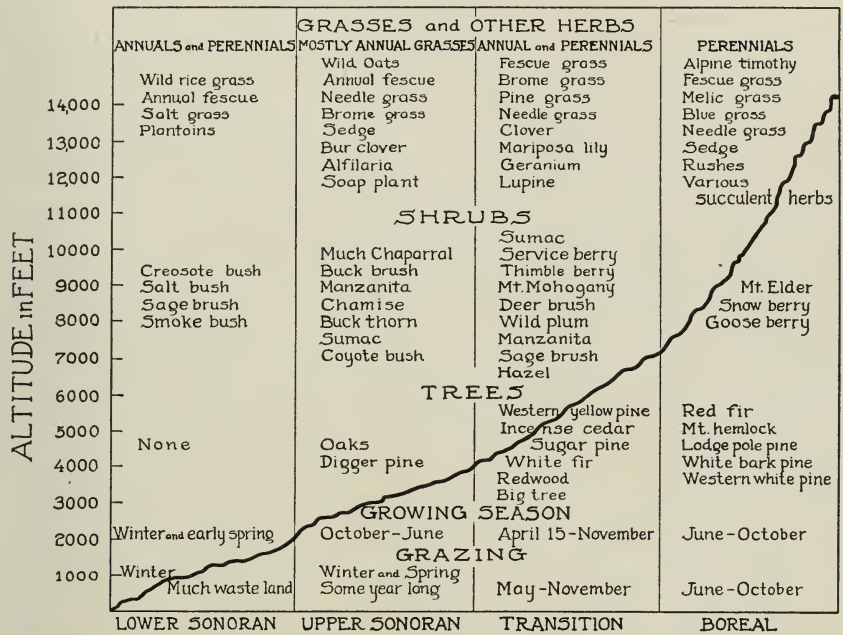

Fig. 24.—Profile showing the life zones and characteristic plants found at various altitudes on the ranges of California. This figure, together with figure 23, shows the relation between the types of vegetation and the altitudes, together with the locations of the range types in California. (After A. W. Sampson; from Bul. 461.)

is composed chiefly of poplar and willow, the latter of which furnishes some browse feed. Upon the large alkali flats encountered here and there, the grasses that do not endure salinity are replaced by saltgrass, saltbushes, and similar plants. Cattle and sheep can exist on these areas and make a fair growth if fed some protein concentrates.

The Upper Sonoran zone comprises the lower foothill belt of grassland bordering the Great Valley, the Coast Ranges of central and southern California, and a slightly elevated chaparral belt of mixed species between elevations of 1,000 and 5,000 feet. It covers approximately 33.0 per cent of the land area of the state. The grasses are chiefly annuals, notably wild oats, fescues, and bromes, intermixed with various highly

palatable species of true clover, filaree, and bur clover. Of the grasslike plants, different sedges and rushes occur in varying abundance. Among the more common brush or chaparral plants are several species of manzanita, mahogany, chamise, and ceanothus. These often form so dense a stand as to prevent livestock from working their way into the areas to gather what little undergrowth of grasses there may be. This zone is valuable chiefly for winter and spring grazing. The grassland and open woodland are well suited for the grazing of both dairy and beef cattle, whereas the browse types are utilized best by sheep and goats.

The Transition zone lies between elevations of approximately 2,000 and 7,000 feet and includes the forest belt, of which ponderosa pine (formerly called western yellow pine), incense cedar, Douglas fir, white fir, and sugar pine are typical, and the coastal redwood area. This zone embraces approximately 26.0 per cent of the land area of the state. The average annual rainfall ranges from about 30 to well over 60 inches. Mean temperatures range mainly from 50° to 60° F, but with considerable variation between summer and winter extremes. Because of the open stand of the timber in all but the coastal redwood area, this zone supports a somewhat luxuriant understory of grasses, herbs, and shrubs, of which annual and perennial fescue grasses, needlegrasses, brome grasses, and clovers and other legumes, are common. Of the many shrubs, the more conspicuous are the huckleberry, serviceberry, mountain mahogany, and species of ceanothus, including deerbrush. The growing season, approximately from May to November, permits grazing from late spring until the autumn rains. Because of the luxuriance of the forest growth, the coastal redwood area does not support so much livestock as the more open pine cover; the glades and open parks of this area, however, are of high grazing capacity.

The Transition zone as a whole contributes abundantly to the forage crop, and although the vegetation becomes somewhat dry late in the summer, it remains fairly palatable, so that stock hold their flesh reasonably well. In the more favored areas along the coast, in both the Lower Sonoran and Transition zones, a grazing type of dairying has supplanted the beef and sheep enterprises.

The Boreal zone, extending from about 7,000 feet elevation to the highest mountain crests, occupies about 4.5 per cent of the area of the state. The mean annual temperature ranges from 40° to 50° F, and the average annual precipitation from about 50 to 70 inches, a large part of which falls in the form of snow. The growing season, the best season for grazing, is approximately from June to October. This zone may be recognized by such commercially valuable trees as red fir, western white pine, lodgepole pine, mountain hemlock, and white bark pine; by such

shrubs as mountain elder, mountain mahogany, thimbleberry, wild cherry, and snowberry; and by such forage grasses as the brome grasses, fescue grasses, bluegrasses, pine grasses, melic grasses, and alpine timothy. Because of the heavy timber growth at intermediate elevations, the grazing capacity is variable and not especially high, but since the range is well watered the forage may be fully utilized.

In the more elevated part of this zone are the cool, late-summer ranges from which cattle may be marketed as grass-fat beef in September and October. This area often supports many plants poisonous to stock. Tall larkspur, which causes the heaviest losses, can usually be controlled either by grubbing out patches or by fencing them from the animals.

The rather limited area above 10,000 feet in elevation is largely treeless. The temperature is low, and frosts may occur almost nightly during the growing period. Most of the vegetation is diminutive in stature. Typical plants are the trisetum grasses, fescue grasses, alpine timothy, buttercup, various sedges, and dwarf shrubs. The period of greatest usefulness is in August, but, in general, this area is of little value for livestock grazing.

Utilization of the Range.—To obtain the maximum utilization of these varied range types, there occurs a marked difference in the localization and a considerable seasonal movement of beef cattle and sheep over appreciable distances in parts of the state. A typical practice in many areas is to graze the livestock in the Lower Sonoran and lower reaches of the Upper Sonoran zones during the winter and as late into the spring as the forage remains succulent; then move them into the Transition zone, and some finally into the Boreal zone for the summer and early fall grazing. Stock ready for market are shipped, frequently direct, from the summer range at the end of the grazing season, and the remainder of the herd is then returned to the lower elevations before the onset of winter. This practice is followed generally, but by no means universally, in the interior of the state by operators who hold grazing permits in the national forests or who own or lease private lands in the high mountain territory. Grazing on the unreserved public domain, over 80 per cent of which is in the desert region, is limited mainly to those who control the available stock-watering facilities.

Such movements of livestock are much less pronounced in the coast regions, where most of the stock are maintained the year round on the same ranch. Some operators, however, drive or ship the market classes to other sections, to be finished for market.

Because of the seasonal movement of livestock, inventories of a specific date, such as those given in the census, are of little value in determining the carrying capacity of the range. Even if weighted by the length of

time grazed, the use of livestock numbers is a poor measure of carrying capacity, for a given range may be overstocked or understocked during any one year, particularly in California, where much of the range forage is made up of annual plant species that respond markedly to variations in seasonal precipitation. Thus, after winters of heavy and well-distributed rainfall, a specific range may have a carrying capacity two to four or more times that which it has in years of light rainfall. Besides climatic variations, the amounts of supplemental feeding and the management practices vary considerably in different parts of the state. Only in a general way, therefore, do the dot maps of livestock numbers, presented in the following sections, indicate the relative carrying capacity of ranges.

The principal producing areas and the geographic distribution of the important types of livestock are shown in dot maps representing the numbers of stock on farms and ranches on April 1, 1930. The dots representing numbers of beef cattle and sheep were placed in reference to the location of stock ranches, data for which were available by minor civil divisions. Although this gives a fairly accurate picture of the situation as of April 1, one must remember that the range livestock would be distributed somewhat differently at other times of the year because of the seasonal movement previously mentioned. The dots representing the other types of livestock were localized according to statistics on numbers of livestock farms and acreages of feed crops, compiled by subdivisions within the counties, and according to occasional local data on livestock numbers.

BEEF CATTLE

Beef cattle are raised mainly under range conditions on relatively large, specialized stock ranches. Except for feeder cattle and a few purebred herds, relatively few are maintained in the more intensive farming areas. Beef cattle (fig. 25) are widely distributed, primarily because of a corresponding distribution in the type of range suited to them.

The open nature of the timber and brush cover, together with the predominance of forage grasses and stock-watering facilities along the eastern side of the San Joaquin and lower Sacramento valleys, in the central-coast counties, and in parts of the northern mountain counties, largely accounts for the heavy concentrations of beef cattle in these areas. Elsewhere somewhat similar conditions provide grazing facilities suitable for cattle raising.

Differences in feed types and in growing conditions, however, tend to subdivide the cattle industry into somewhat specialized fields in different localities. Imperial County, as well as parts of Riverside and San Diego counties, is highly specialized, since all the native forage, together

with that produced under irrigation and fed to beef cattle, is used for finishing the animals, practically all of which are imported from neighboring states and from Mexico. Feeders are imported each fall, finished during the winter and spring, and marketed before the hot weather and in advance of supplies of grass-fat stock turned off the ranges to the north.

The coast counties from San Diego to Del Norte, the northern mountain counties, and the mountain region from Modoc south to Kern County are used mainly as breeding and finishing grounds, with some importa-

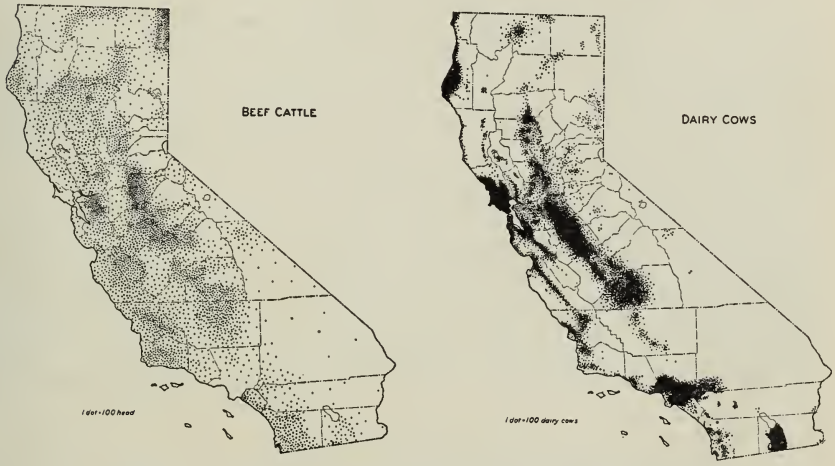

Fig. 25.—Distribution of cows and heifers for beef and dairy cows and heifers kept for milk.

tion of cattle, especially in years of abundant forage growth. The national forests in the north-coast and mountain counties contribute to the summer-foraging requirements. Here the principal factor limiting the number of livestock is the amount of fall and winter feed available. The critical period of the year is between the first fall rains and the time when the new growth is sufficient to support the cattle. Winter feeding of hay and some concentrates becomes increasingly prevalent toward the north and almost universal in the northern mountain counties.

Some range stock is maintained in the Great Valley for a short period during the winter, but this region is important mainly for growing out and finishing beef cattle. A large area in Kern County with a northerly extension in the trough of the Valley to Merced County, unsuited to cultivation, is used mainly to pasture feeder cattle. Similar areas elsewhere are used to some extent for the same purpose, and increasing numbers of such cattle are being maintained on irrigated pastures or fed out on farm and mill by-products.

The Hereford and Shorthorn breeds predominate. Some herds of Aberdeen Angus are maintained, usually on fenced pastures rather than on the open range because this breed is not well adapted to range conditions. Crossbreeding of Herefords and Shorthorns is common in some areas, particularly in the northeastern counties, where many ranchers milk during parts of the year. Despite considerable variation in practice, beef cows are usually bred to calve in the spring, when the succulent feed available insures maximum milk flow and provides desirable pasture for the young calf. The young stock are marketed mainly as long yearlings or two-year-olds, either as grass-fat or finished cattle, according to local conditions. In the north-coast and northern mountain regions and in local areas elsewhere, the tendency is to dispose of calves and yearlings as stockers or feeders to be grown out and finished for market in other parts of the state—principally in the San Joaquin Valley and central-coast region. Some baby beef is produced, but the demand at prices profitable to growers is decidedly limited.

Feed yards have been established near Los Angeles, San Francisco, and Stockton, and at other strategic points to supply the demand, increasing in recent years, for a better-quality carcass than is supplied by most grass-fat stock. In these yards, hay, grain, and some protein concentrates are fed for periods ranging from 60 to 100 days, after which the cattle are turned directly to the stockyards for slaughter.

DAIRY CATTLE

As is shown by the distribution of dairy cattle (fig. 25), dairying is conducted under widely diverse environmental conditions. Four major types of dairying may be readily distinguished: (1) the alfalfa and dairy-cow combination prevailing in the Great Valley and in other irrigated valleys; (2) the dry-lot dairies of the Los Angeles market-milk area; (3) the coastal grazing type of dairying most prominent in Humboldt, Sonoma, Marin, and San Luis Obispo counties; and (4) the dual-purpose type of the high mountain areas.

In the larger coastal and interior valleys, where irrigation facilities are available, alfalfa is the principal roughage fed to dairy cows. Local practice varies considerably in regard to the amounts of alfalfa cut for hay and used for pasture, as well as in the extent to which alfalfa is supplemented by other pasture crops (for example, Ladino clover, oats, and vetch or Sudan grass), or by silage, or by the feeding of concentrates. Holstein cows predominate, and freshening occurs the year round. Most of the production is sold as whole milk or cream for manufacturing, although some operators produce market milk for nearby centers of population and for the San Francisco Bay cities.

The chief sources of the milk supply for the Los Angeles metropolitan area are the dry-lot dairies of that vicinity. Both fresh cows and feeds are shipped in from outlying districts. The cows, kept mainly in dry lots or corrals, are fed heavily on alfalfa hay and on such concentrates as barley, beet pulp, and cottonseed meal, sometimes supplemented with silage and only occasionally with pasture. Although Holstein cows predominate, many Jerseys and Guernseys are used to insure a milk-fat content above the legal minimum requirement. Under this plan no dry cows are maintained nor calves raised. Cows about to freshen are shipped in at all seasons to maintain a relatively constant volume of product.

The coastal grazing type shows less uniform characteristics from area to area than the preceding types. Grazing of native or improved pastures predominates and forms the chief source of feed for the stock. The dairy section of Humboldt and Del Norte counties, characterized by heavy precipitation, long growing season, and cool summers, is confined largely to the bottom lands along the rivers and to contiguous cutover pastures composed largely of clovers and rye grass. Most operators do considerable supplemental feeding of roughages, including root crops, when the pasture is short, and feed some concentrates during all or part of the year. Jersey cattle predominate, and the cows are bred to freshen in January, February, or March. Most of the production is sold to butter and cheese factories in the area.

In the counties abutting on San Francisco Bay, chief reliance is placed upon the native grass pastures on the open rolling hills and on the marshlands bordering the Bay. Supplemental feeding of alfalfa, grain, or native grass hay put up on the farms or of alfalfa hay imported from producing sections is practiced after pastures are past their prime. In the coastal sections of Marin and Sonoma counties cows of mixed breeding are common, but elsewhere the Holstein predominates. Numerous market-milk dairies in this area supply the Bay cities with milk and cream. The others sell whole milk or cream for the manufacture of butter and some cheese.

In the coastal sections of San Luis Obispo County, dairying has largely supplanted beef cattle or sheep raising on the more open and less-rugged ranges. Because of the humidity and the more equable temperatures along the coast, the native forage grows for a longer period than in the interior but does not possess qualities suited to the fattening of livestock. Succulent feed is available usually from November to July, which provides conditions better suited to dairy cows than to beef cattle or sheep. In these areas most operators breed their cows to freshen from October to December and allow them to dry up as the green feed fails. Some, however, provide supplemental feeds during the summer and milk the year

round. Much of the stock is of nondescript breeding. Partly for this reason and partly because of feeding practices, annual production per cow is relatively low.

The scattered dairy-cow population in the mountain territory is made up largely of dual-purpose-type cattle maintained by operators of the smaller stock ranches. Usually only a few cows are kept in the milking string and, when dry, are turned out on the range with the beef herd. Durham or milking Shorthorns, frequently crossed with Hereford blood, are the predominating type. In addition, some herds of dairy cattle are

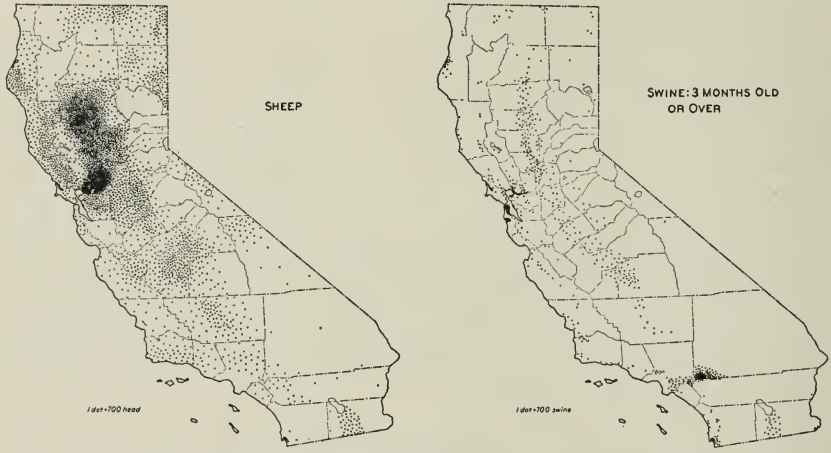

Fig. 26.—Distribution of sheep and swine three months old and over.

to be found in the Shasta Valley of Siskiyou County, the Honey Lake Valley of Lassen County, and other large mountain valleys. The product is handled mainly by local creameries in each area.

SHEEP

The sheep population (fig. 26) is widely distributed over the state, but with marked concentrations in the Sacramento and San Joaquin valleys, noticeably lighter concentrations in the north-coast and northern mountain counties, and relatively limited numbers in the central-coast and southern counties. Sheep raising is conducted under both farm and range conditions, the former being most highly developed at present in the lower Sacramento Valley but becoming increasingly important in other sections. Both types now operate mainly on a ewe-and-lamb basis, with principal emphasis in the major producing areas upon early lamb, for which there has been a ready market in the eastern centers of population.

In the Great Valley, farm flocks are maintained principally on native

pasture, volunteer grain fields, and grain stubble and beet tops during the summer and fall. Irrigated pastures are becoming increasingly popular in some sections. Alfalfa hay and frequently some concentrates are fed at lambing time, which usually extends from November to January. The lambs are marketed from late March to May, at about 4 months of age, and are among the first to reach the markets. Medium-wool breeds, especially the Hampshire and Shropshire, are the most popular, although rams of these breeds and the Suffolk are sometimes crossed with Rambouillet ewes.

The foothills bordering the Great Valley provide winter grazing and lambing grounds for thousands of head of range ewes. Green feed is available from about November 15 to May 1. Most of the ewes lamb during January and February; the early lambs are marketed during the latter part of April and May; and the others are driven to the summer ranges with the ewes and are marketed about July. As the feed dries up, many sheepmen in the northern part of the Sacramento Valley and in parts of the San Joaquin Valley trail or ship their stock to the high mountains for summer grazing on the national forests or on private lands. Others rely on privately owned or leased pastures and grain stubble for summer and fall grazing. Many sheep are moved into the Sacramento—San Joaquin Delta each fall, where an abundance of beet tops, stubble, and other crop residues is usually available. Although their numbers are decreasing, some "tramp" sheep operators owning little or no land still trail over wide areas each year to graze their sheep upon leased pastures and upon the public domain. Thus, the range-sheep industry tends to be even more nomadic than the cattle industry.

In the mountain counties, sheep are grazed during the summer in the national forests and on the public domain and are wintered on hay put up in stacks on the home ranches. In Modoc, Lassen, and the adjoining counties in Nevada, there is considerable desert land in the public domain where large bands of sheep are wintered on the sagebrush and on other forage species before being driven to the mountains toward the west for summer grazing. Throughout the mountain counties lambing is considerably later than in the valley. Most of the lambs are dropped during April and are shipped to market in the fall. The Rambouillet is the dominant breed of the range industry, with some cross-breeding to mutton types.

The north-coast region, particularly in its northern half, differs from other range areas in placing greater emphasis upon wool production, for which long-wool and fine-wool breeds are used. Along the coast, Cotswold, Romney, and Dorset are favored, whereas inland the Delaine Merino predominates. The wools are noted for their fineness, length of

staple, and light shrinkage. Another characteristic of this region is that many sheep are grazed throughout the year in large fenced pastures, usually with little or no supplementary feeding. Some operators, however, drive to the mountain areas for summer grazing. Early-lamb production is impracticable because of the lateness of the season and can be undertaken safely only when barns or sheds and winter feed are supplied. Lambing on the range occurs during February and March, and the lambs are marketed in August and September. Considerable numbers are shipped as feeders to the interior valleys, where they are fattened on stubble or on irrigated pasture or put directly into feed lots.

The relatively heavy sheep population in the Imperial Valley results from the use of that section as a winter lambing and feeding ground. Because of the high temperatures and the scarcity of pasture during the summer, sheep are not carried the year round in this area. Early each fall hundreds of head of old ewes, bred to lamb in November and December, are imported into the Imperial Valley, where they are maintained and the lambs fattened on alfalfa pastures or on alfalfa interplanted with barley. After these lambs—the earliest produced in the state—are marketed, the ewes are usually fattened and sold. Also, numerous feeder lambs imported from the range states each fall are fattened on grain stubble and alfalfa pastures, supplemented with concentrates.

Thus, the California sheep industry supplies as its present major product a succession of "spring" lamb crops extending well over the five-month period between March and July, with some late lambs from the northeast counties in August and September.

Although perhaps of secondary importance to the lamb crop in most sections of the state, the wool crop is not neglected in breeding and management practices. California produces one of the largest and one of the most variegated clips of any state in the Union. Annual production ranges usually from 22,000,000 to 27,000,000 pounds. The great diversity in environmental conditions results in the use of many different breeds of sheep and managerial practices. The custom of shearing twice a year in some sections and once a year in others causes the length to vary as much as the grade and character.

The California clip is composed primarily of fine wools, for sheep raising is largely a range enterprise and the fine-wool sheep are best adapted to the range conditions in most parts of the state. Also ewes in the valley flocks, maintained mainly for early lamb production, generally represent a good deal of fine-wool blood. Quality ranges through wide extremes. The northern counties produce some of the best wools in the United States whereas much of the clip from the central and southern parts of the state is short and defective.

Because of wide differences in clips from various sections, the wool trade recognizes four major supply areas in its classification and buying practice, namely, the north-coast, the northern interior, the middle, and the southern counties.

The north-coast counties support a relatively heavy sheep population, mainly of a straight Merino blood or of Merino and Rambouillet extraction. The clip generally is exceedingly bright and clean, of good color, low shrinkage, and general good quality but may lack loftiness and bulk as compared with wools of the same grade from other sections. Along the coast and particularly in the river valleys of Humboldt County, the long wools are very popular. The fleeces from these sheep, however, constitute only a small proportion of the clip of the north-coast area. One shearing a year, usually in April–June, is the prevailing practice of this area; hence the wools have the relative uniformity of twelve months' growth as compared with two-shearing areas.

The northern interior counties include the rough northern mountain area and that portion of the Great Basin extending into California. In this area the Rambouillet is the predominant breed although some growers prefer the crossbreeding of fine-wool or long-wool or medium-wool types, the latter producing fleeces which grade mainly fine medium and half blood. The clip of this area is almost wholly of twelve months' growth, somewhat less attractive in appearance and of higher shrinkage than the coast wools but more likely to be sound. Some clips from flocks that graze part of the year on farming lands in the Sacramento Valley may carry seed defect but usually not enough to warrant carbonizing.

The middle counties area includes the main body of the Sacramento Valley, the northern San Joaquin Valley, and the Sierra Nevada adjacent thereto and the coast counties abutting on the south and east shores of San Francisco Bay. Sheep raising under farm conditions or where farm and range lands are combined is much more prevalent than in the northern areas and far more use is made of the mutton breeds. The clip, therefore, in large measure tends toward medium grades, and because of growing conditions and the usual practice of shearing twice a year, is of a highly varied character. The spring clip of about seven months' growth is fairly free of vegetable defect; the fall clip of about five months' growth is short, dirty, and so defective that practically all must be carbonized. These wools are usually sound and well grown but tend to be rather harsh and dirty as compared with northern grown wools and not so attractive.

The southern counties area, comprising the entire southern half of the state, produces the least attractive clip of any of the designated areas. Produced in a region of low rainfall and high, summer temperatures,

the wools are heavily loaded with dirt and sand, are shorter in staple length, much more defective, and have higher shrinkage than similar wools from the northern areas. The sheep are shorn usually twice a year. Some of the spring clip and all of the fall clip must be carbonized. Fine wools predominate, but the fleeces show less care in breeding than in the northern flocks.

SWINE

Hog production is the least important of the major livestock enterprises as may readily be seen by comparing the maps of distributions (figs. 25 and 26). In relation to both its area and its population, California raises far fewer hogs than many states and less than the average for the nation. During recent years from 60 to 70 per cent of the pork and pork products consumed in the state have been shipped in. Despite this great deficiency, hog raising has not become important in California, probably for three major reasons: (1) Hogs cannot utilize the range so advantageously as other classes of livestock. (2) Only limited areas of native pasture are suitable for hog raising; and cultivated pastures, because of the general necessity for irrigation, are expensive to maintain. In some areas such pastures are necessary to supplement the range, whereas elsewhere other classes of livestock will apparently net greater returns than hogs. (3) The barley-hog ratio is subject to wide and abrupt fluctuations.[23] Barley is the principal concentrate produced in California that is suitable for hog feeding. To a considerable extent its price depends upon the demand for malting and upon the feed requirements for other classes of livestock as well as for hogs. The abrupt fluctuations in the relation between barley prices and hog prices operate to the disadvantage of producers who are forced to rely upon barley as the principal concentrate feed. In consequence, a large proportion of the hogs raised in California are maintained chiefly on the waste or by-products of the farms and processing plants.

Hog raising is carried on in practically all agricultural areas of the state. Though the largest numbers of swine are in the Sacramento and San Joaquin valleys (fig. 26), there is no marked concentration in any particular local area. The heavy concentrations near Los Angeles and San Francisco are occasioned by large garbage-feeding establishments, and that in western San Bernardino County results mostly from the garbage-feeding operations of one gigantic plant, reputedly the largest in the United States. Except for these establishments, the swine industry in this state is less highly specialized than the other livestock industries. Hog production is mainly a side-line enterprise on the grain and field-

[23] Voorhies, Edwin C., and Martin H. Blank. Swine (series on California crops and prices). California Agr. Exp. Sta. Bul. 523:104–7. 1932. (Out of print).

crop farms of the interior valleys and on dairies producing milk fat. Some feeder hogs are raised under range conditions in the woodland areas adjacent to the Great Valley and in the coast regions in conjunction with other livestock enterprises. On most of these farms five to ten sows constitute the typical unit, with relatively few maintaining larger breeding herds. The feeder pigs are sold to garbage establishments; to dairy, grain, or other types of farms having surplus or by-products feeds; or to dealers for export to the Hawaiian Islands.

POULTRY

Poultry raising in California is a highly specialized industry and, with few exceptions, is designed almost exclusively for egg production. The Census of Agriculture reported chickens on slightly over 60 per cent of the California farms in 1930.[24] Nearly 75 per cent of the chickens, however, were on poultry farms, which comprise only 11 per cent of the farms of all types. The principal centers of production, as evidenced by the distribution map (fig. 27), are in Sonoma County (popularly called the Petaluma district), in Los Angeles, and in adjoining counties of San Bernardino and Riverside. Minor concentrations occur in Alameda (Castro Valley district), Sacramento (Rio Linda district), San Diego, and Santa Cruz counties. The large number of chickens in these areas are found mostly on the numerous specialized poultry farms of small acreage. The average laying flock consists of 700 to 800 birds, though a few large-sized commercial plants maintain several thousand birds each.

Fig. 27.—Distribution of chickens three months old and over.

The relatively large but scattered poultry population in the Great Valley, on the other hand, is due not only to the presence of specialized farms but also to large numbers of small flocks maintained as side-line enterprises on various types of farms, particularly in the smaller-sized groups. Even here the poultry unit resembles the specialized poultry farm. Chief reliance is placed upon purchased feeds and upon the purchase of day-old chicks for flock replacement. Major emphasis is upon

[24] United States Bureau of the Census. Fifteenth Census of the United States, 1930. Agriculture. The Western States. 3(3):404. 1932.

egg production, for which the white Leghorn breed is most popular. Since relatively few flocks of the heavy breeds are maintained, meat production is primarily a by-product of the egg industry. Cockerels, cull pullets from the young stock raised for flock replacement, and cull hens form the chief supply of poultry in California.

The state in general is a surplus-egg-producing area but operates definitely as a deficit area in poultry meat production. Large quantities of eggs are shipped annually, mainly from the northern producing areas to New York and to other centers of population in the east; and carlot shipments of meat birds are imported from the Middle West to supply local markets. Ducks, geese, squabs, and other fowl, augmenting the poultry-meat supply, are raised in limited amounts for local markets mainly in Los Angeles and Sonoma counties.

TURKEYS

As with chickens, turkey production is highly specialized. While there are many small farm flocks widely distributed over the state, a high percentage of the turkeys raised comes from large flocks on farms where turkeys are the sole or main source of income. Production centers mainly in the Sacramento and San Joaquin valleys and in certain parts of the southern counties of Los Angeles, Riverside, and San Diego (fig. 28).

Turkeys, inherently, are dry-land birds thriving in the dry climate and arid atmosphere of the interior valleys and even the desert region. Widespread adoption, in recent years, of newly developed methods and management practices—artificial incubation and brooding, disease-control measures, refrigeration and storage, transportation and marketing—has contributed to the establishment and growth of this industry. More recently, the production of turkey hatching eggs for local and out-of-state hatcheries has assumed considerable importance. This phase of the industry has been emphasized in the southern producing sections where the climate is favorable to egg production. Growers in the southern districts likewise have adopted, almost universally, artificial methods of hatching and brooding, and raise the birds in close or semiconfinement without range.

Typical breeding flocks number about 300 hens. Occasional units of 1,500 or more hens are encountered, but these are rare. The number of turkeys raised annually by commercial producers ranges generally from about 1,000 to upwards of 5,000 birds.

In the Great Valley and other producing districts there is less uniformity in production methods, some following closely the practices of the southern growers, but, in general, natural incubation and brooding and more frequent and fuller use of range are probably more common.

Many flocks are herded in large bands, like cattle or sheep, over native ranges and after the harvest on croplands in the Valley. A typical practice is to finish market birds on barley, wheat, or rice stubble, topping off with short periods of supplementary feeding.

In spite of a marked increase in turkey production in recent years, the state is operating on a net deficit basis. The birds are marketed mainly

Fig. 28.—Distribution of turkeys raised in California in 1929. (From Bul. 612.)

through the two central markets—Los Angeles and San Francisco—through producers' coöperative marketing associations, consignment to produce dealers, or through sales to hucksters, local butchers, or central market dealers. Most growers now deliver their birds alive to killing plants equipped with cooling and packing facilities, instead of killing and sometimes dressing the birds on the farm as was formerly standard practice. Although fresh killed or dressed storage birds are available now the year around, there are two distinct marketing periods for turkeys. The main season runs from October to January or February when most of the young turkeys are sold; the second and less important season runs from March or April to June when discarded breeder hens and late-maturing young stock are sold.

GEOGRAPHIC DISTRIBUTION OF TYPES OF FARMS: CENSUS CLASSIFICATION, 1930

In the preceding sections, the localization of the various crop and livestock enterprises is given on the basis of crop acres and livestock numbers. Causal or contributing factors to this localization are described in some detail and general comparison made of cropping conditions in the major physiographic areas of the state. Acreage and livestock numbers are not necessarily reliable indexes of what constitutes the farmer's main occupation or business because of the marked differences in the amounts of labor, power, materials, and management applied on each unit of the different enterprises and in the gross or net returns accruing.

In some areas, differences in the nature and combination of enterprises making up the farm unit adequately distinguish or differentiate the types of farming prevailing. In other more specialized areas, such as California, the source of gross or net income may distinguish the prevailing types of farming more adequately than would any attempted comparison of combinations of enterprises. In this section, therefore, the relative importance of the different types of enterprises to the farm economy will be indicated through the use of data of the Census of Agriculture tabulated for the first time in 1930 by types of farms.[25] This special tabulation presents the number of farms, farm acreage, value of specified farm property, value of farm products sold or traded, specified farm expenditures, numbers of livestock, sizes of farm, and tenure of operator for each of eleven major types of farms, together with somewhat less information regarding a group of five noncommercial farm types classed as "abnormal farms."

Source of income is the primary basis for classifying the farms. For example, nine of the major types are determined by the fact that 40 per cent or more of the total value of all products of the farm is derived from the sale (or anticipated sale) of specified products or groups of products; differentiation for the others is by selected distinctive characteristics. More specific definitions follow:[26]

1. *Cash-grain farms.* Those that derive 40 per cent or more of their total gross income from corn, wheat, oats, barley, flax, rye, spelt, buckwheat, rice, and grain sorghum.
2. *Cotton farms.* Those that derive 40 per cent or more of their total gross income from cotton (lint) and cottonseed.

[25] United States Bureau of the Census. Fifteenth Census of the United States, 1930. Agriculture. Type of farm. 3(3):383–427. 1932.

[26] For complete definitions of major types and subtypes see: United States Bureau of the Census. Fifteenth Census of the United States, 1930. Agriculture. Type of farm. 3(3):2. 1932.

3. *Crop-specialty farms.* Those that derive 40 per cent or more of their gross income from sweet sorghum for sirup, sugar cane, sugar beets, maple sirup and sugar, soybeans, cowpeas, velvet beans, ripe field peas and beans, hay, tobacco, peanuts, white potatoes, sweet potatoes, mushrooms, and other minor field crops.
4. *Dairy farms.* Those that derive 40 per cent or more of their gross income from milk, cream, milk fat, butter, dairy cows, and calves.
5. *Fruit farms.* Those deriving 40 per cent or more of their total gross income from small fruits, such as strawberries, raspberries, blackberries, and cranberries; and all tree fruits, nuts, and grapes.
6. *General farms.* Those in which (1) the value of the products from any one source was less than 40 per cent of the total value of all the products of the farm or (2) the value of the product from each of two sources represented 40 per cent or more of the total gross income—except for such special combination types such as fruit-truck, when the farm was classified according to the type dominant in the locality.
7. *Truck farms.* Those that derive 40 per cent or more of their total gross income from vegetables.
8. *Poultry farms.* Those that derive 40 per cent or more of their total gross income from chickens, ducks, geese, turkeys, or chicken eggs.
9. *Animal-specialty farms.* Those that derive 40 per cent or more of their total gross income from any or all classes of beef cattle, sheep, hogs, wool, mohair, and slaughtered animals. These farms emphasize the raising of crops and the feeding of livestock and are distinguished from stock ranches by having in pasture less than ten times the acreage in crops.
10. *Stock ranches.* Those that emphasize chiefly the production of livestock (usually beef cattle, sheep, or goats) by grazing. The distinction between animal-specialty farms and stock ranches rests in the ratio of pasture land to acreage in crop. When the acreage in pasture is more than ten times the acreage in crops, the property is classified as a stock ranch; when less, as an animal-specialty farm.
11. *Self-sufficing farms.* Those in which the value of the farm products used by the operator's family was 50 per cent or more of the total value of all the products.

Besides these eleven major types, several subtypes fall under the general class of "abnormal farms," the most important of which in California are of the "part-time" sort, in which the operator spent 150 days or more off the farm, in other than agricultural work, or reported an occupation other than farming, provided the value of the farm products did not exceed $750.

Published information on types of farms is available only by states and counties. An unpublished tabulation of the approximate numbers of farms of each type by minor civil divisions in California was made available and used in making figures 29, 30, and 31 to show the location and the relative importance of the several farm types in various parts of the state. Comparison between these figures and the distribution of crop acreages (figs. 9 to 21), when grouped to conform with those included in each farm type, shows marked similarity in both density and distribution, though not without some exceptions. These relations indicate the

high degree of specialization in farm organization prevailing in California.

Cash-grain farms are concentrated largely in the Sacramento and northern San Joaquin valleys; they thus conform in general with the heavy concentrations of barley and wheat that are the principal crops of these farms. The relatively few farms and large acreage of small grains

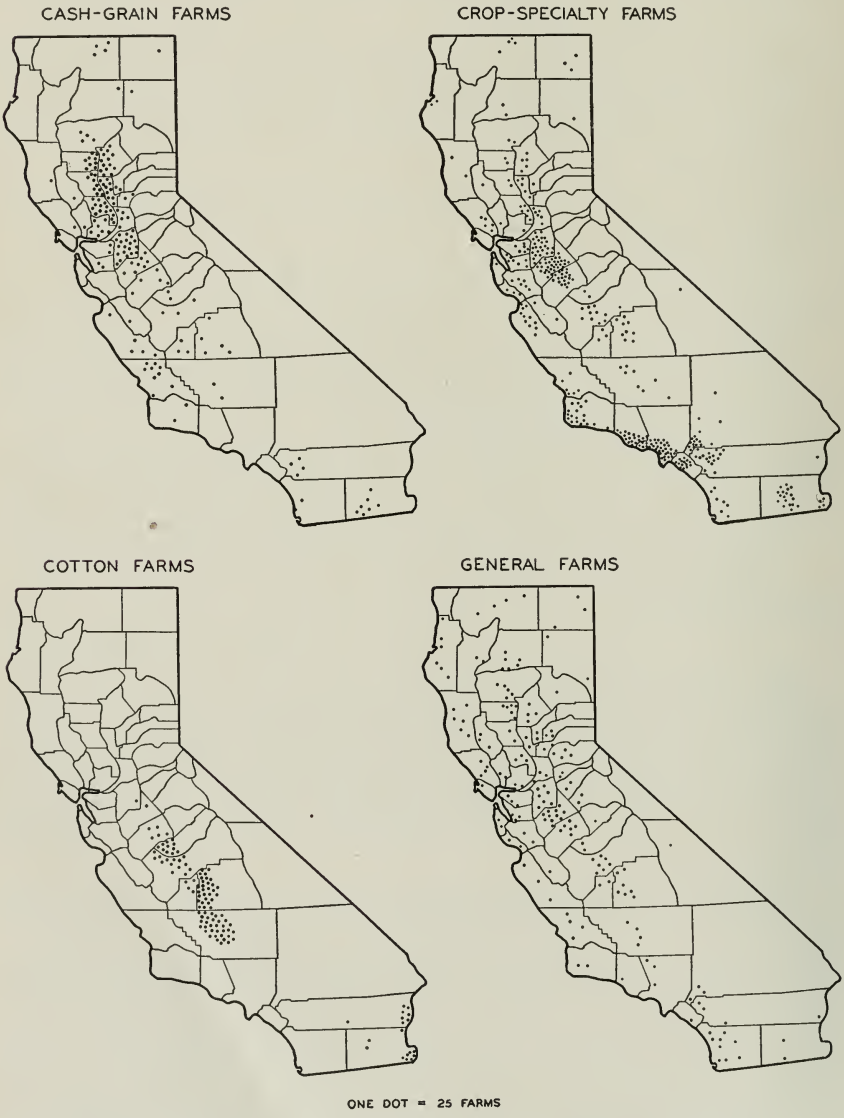

Fig. 29.—Approximate number and location of cash-grain, crop-specialty, cotton, and general farms in California, 1929.

in the southern San Joaquin Valley are accounted for mainly by the large size of holdings, particularly in the Tulare Lake section. Whereas in the Sacramento Valley the majority of these farms is of less than 500 acres, in the San Joaquin Valley the majority exceeds 500 acres each.

Cotton farms predominate in Kern County, in the Palo Verde Valley of eastern Riverside County, and in the Yuma Project in Imperial County. Their numbers are also relatively important in parts of Tulare, Fresno, Madera, and Merced counties. In 1929 about two fifths of these farms were tenant-operated. Most of the cotton farms range in size from 20 to 80 acres and about two thirds of the total number are 160 acres or less. Relatively few exceed 500 acres, and these are more diversified than the smaller farms, where specialization prevails.

Crop-specialty farms in California are devoted primarily to the production of hay and seed, ripe field peas and beans, Irish potatoes and sweet potatoes, and sugar beets. Though widely distributed over the irrigated areas of the state, the greatest concentrations occur in the south-coast region and in the northern San Joaquin Valley, where these crops are prominent. In acreage these farms tend toward the medium-sized units. Nearly half are from 20 to 100 acres, with relatively few exceeding 175 acres.

General farms, though about equal in numbers to cash-grain farms, occupy only slightly more than one fourth the acreage of the latter. In comparison with other types they are relatively few and are distributed widely over the agricultural areas (fig. 29). In size, this type is generally comparable with cotton and crop-specialty farms.

Fruit farms are the most prominent type in California, accounting for approximately 38 per cent of the total number of farms. In occupying slightly more than 10 per cent of the farm land, their total acreage is exceeded only by that in stock ranches and is nearly equaled by that in cash-grain farms. Fruit farms tend toward the smaller-sized units. Approximately 60 per cent of them range in size from 10 to 50 acres, and 89 per cent are less than 100 acres. Heavy concentrations of fruit farms (fig. 30) occur in the lower and central Sacramento and San Joaquin valleys, in the coast counties abutting on San Francisco Bay, and in the southern coastal plain and interior valleys, corresponding to the concentrations of grapes, deciduous fruits, and subtropical fruits (figs. 16, 19, and 20), all of which fall under this classification.

Poultry farms rank second to fruit farms in numbers but, because of their relatively small size, occupy only about 1.4 per cent of the land in farms. Nearly 80 per cent are of less than 20 acres; and over 90 per cent, less than 50 acres each. Their importance rests not alone in numbers but also in volume of business. They contributed about 9 per cent

of the total value of all farm products produced in California in 1929, being exceeded in value only by fruit, truck, and dairy farms. As poultry raising in this state is a highly specialized industry, the concentration of poultry farms in the San Francisco Bay counties and about Los Angeles, with scattered occurrence elsewhere, corresponds very closely to the distribution of poultry numbers (fig. 27). There is a rela-

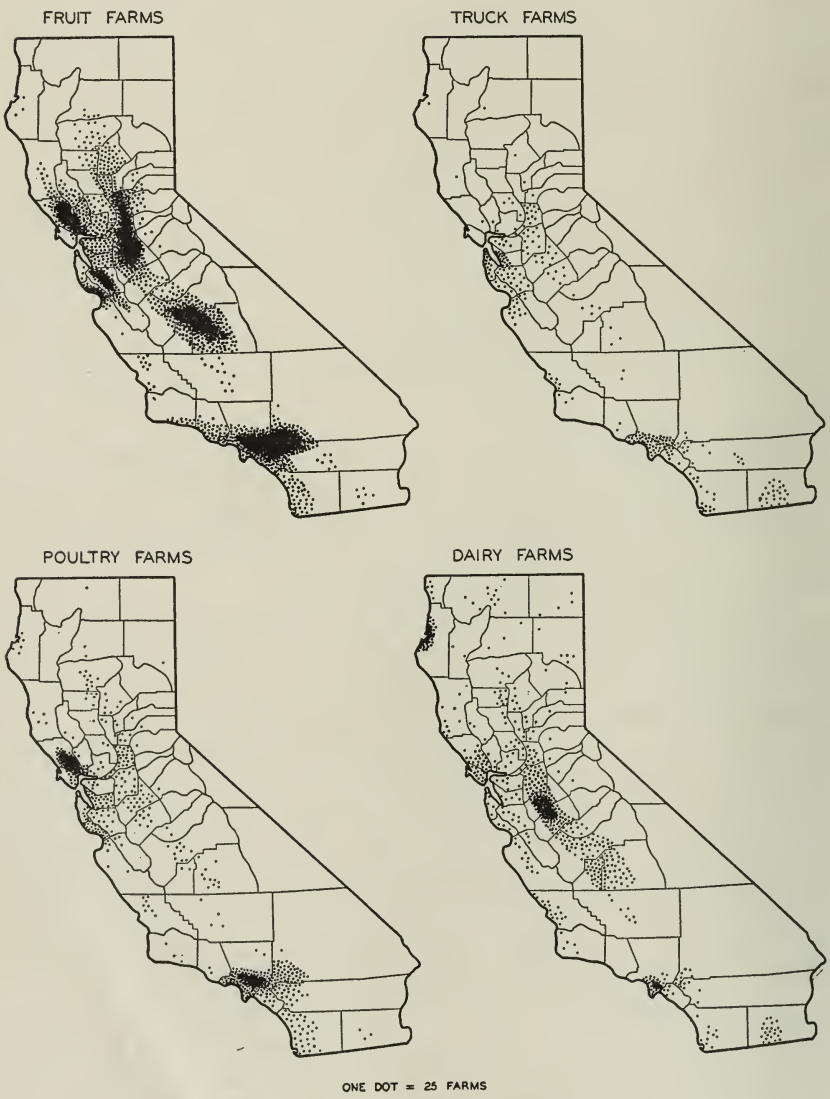

Fig. 30.—Approximate number and location of fruit, truck, poultry, and dairy farms in California, 1929.

tively greater poultry population in the Great Valley than the numbers of such farms would indicate, for in this area more flocks are maintained as side-line enterprises than in most other parts of the state.

Truck farms are intermediate in numbers between general farms and crop-specialty farms but tend to be somewhat smaller than either. They occupy only about two thirds as much acreage as general farms and one third as much as crop-specialty farms. Approximately one half of them range from 10 to 50 acres, and over four fifths are of less than 100 acres. They produce a long and varied list of vegetables which, in general, are crops of high unit value. Measured in terms of the gross value of the product, the volume of business on these relatively few farms and small acreage is considerable, being exceeded in total value, in 1929, only by the fruit crops and dairy products of the state.

Dairy farms rank third in numbers and fourth in acreage. They are distributed more widely and somewhat more uniformly over the agricultural areas than most other farm types, mainly because of the several types of dairy farms included in this group and because of a general tendency to concentrate market-milk production near centers of population. In the interior valleys the alfalfa-dairy combination predominates, accounting for the large number of dairy farms in these areas. Near the coast a grazing type of dairying prevails in which reliance is placed mainly upon natural grass pastures and hay, occasionally supplemented by other feeds during a part of the year. The concentration of dairy farms near Los Angeles is accounted for largely by the numerous dry-lot dairies operated virtually as milking depots on the basis of purchased feeds and fresh cows shipped in from outlying districts. In the mountain counties a few specialized dairies using dairy breeds are to be found, but reliance is placed chiefly upon dual-purpose-type cattle for milk-fat production maintained in conjunction with beef-cattle enterprises on the same ranches.

Because of the varied conditions under which dairying is conducted, sizes of dairy farms measured in terms of acres, numbers of cows, or volume of business range through rather wide extremes. Except in the mountain areas, however, most of these farms are rather highly specialized, the majority comprising either one- or two-man dairy units, with acreages and volume of business varying in different parts of the state according to the cropping and feeding programs and to the type of commodity produced.

Animal-specialty farms, as previously indicated, are those engaged principally in the production of feeds and the feeding of livestock. This classification includes numerous subtypes such as hog farms, diversified livestock organizations, purebred-stock farms, and the smaller, more

intensively operated beef-cattle and sheep enterprises. Beef cattle are probably the most important class of livestock on these farms, for approximately 70 per cent reported beef cattle, whereas only slightly over 50 per cent maintained swine of any type, and, although sheep are not reported, other data indicate that they are relatively unimportant on these farms. Of the farms reporting beef cattle, only about 35 per cent

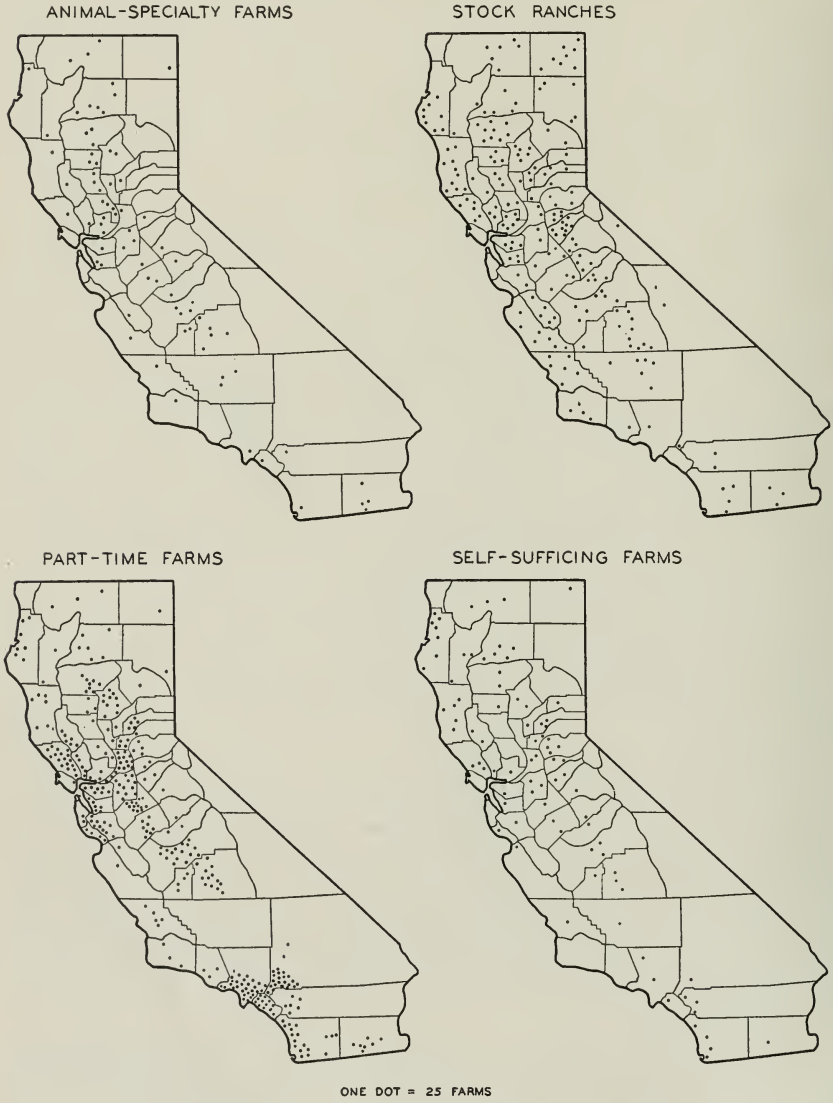

Fig. 31.—Approximate number and location of stock ranches, animal-specialty, part-time, and self-sufficing farms in California, 1929.

had beef cows and of those reporting swine only 42 per cent had sows. The remainder rely on the purchase of feeders for their supply.

Most animal-specialty farms are relatively small, more than 50 per cent being of less than 175 acres, and over 80 per cent of less than 500 acres each. In contrast with the stock ranches, they are relatively few and are located mainly in the Great Valley and the adjoining foothills.

Stock ranches constitute only 3.8 per cent of the total number of farms of the state. In comparison with the animal-specialty farms, they tend toward larger acreages and more extensive production. Over 72 per cent of the stock ranches exceed 500 acres, and slightly more than 10 per cent exceed 5,000 acres. On animal-specialty farms in 1929, about 25 per cent of the total acreage was planted to crop and harvested, and over 40 per cent was rated as arable land; whereas on stock ranches less than 3 per cent of the total acreage was cultivated, and only about 7 per cent was rated as arable. Thus, in stock-ranch operation, chief reliance is placed upon the grazing of livestock on the native range, in contrast with the cropping and feeding practices of the animal-specialty farm.

Although relatively few in numbers, stock ranches occupy nearly fifteen million acres, or almost 50 per cent (49.1 per cent) of all *land in farms* in the state. As indicated above, only a small part of this vast acreage is at all suited for crop production, and the rest is made up of pastures and range of various types, timber, and wastelands. Stock ranches are distributed rather widely and fairly uniformly over the range territory of the state (fig. 31) which, in general, conforms to the grass, brush, and parts of the timber belts depicted in plate 1.

Self-sufficing farms are the least important major type in both numbers and acreage. They are most numerous in the foothill areas bordering the Great Valley and in the more isolated sections of the mountain and north-coast counties. They exhibit a wide range in size—from less than 10 acres to over 500 acres—the majority, however, being of less than 50 acres each. Somewhat less than 20 per cent of their total acreage is arable land, and only about 7 per cent was cultivated in 1929. Incomes, as might be expected, were low; 70 per cent of their number reported gross incomes of less than $400, and less than 1 per cent (0.36 per cent) reported incomes exceeding $1,000 in 1929. This classification includes typical "hillbilly" farms and Indian allotments, neither of which produce agricultural products commercially to any great extent.

Part-time farms are the most important type of the group classified as "abnormal" and are most numerous near the large industrial centers of the state where employment opportunities generally are greatest. Considerable numbers also are scattered throughout the Great Valley and the north-coast counties of Lake, Napa, and Sonoma. Their presence may

be accounted for here as elsewhere partly by the desire of some townspeople to live in the country, to reduce living costs, or to increase incomes by farming on a small scale; and partly as a result of the subdivision of farm lands into uneconomic units, eventuating in the necessity for outside employment for the operators of these small holdings. In general, data pertaining to part-time farms reveal a tendency toward small size, low farm income, and a relatively high percentage of tenancy.

When grouped in accordance with the census classifications used in defining farm types, a marked correlation exists between the location and relative density of numbers of the different types of farms and in the acreages of crops or livestock numbers. Deciduous-fruit farms, for example, are concentrated in areas where acreages of these fruits are greatest, crop-specialty farms where these crops are concentrated, and livestock ranches mainly where the relative density of beef cattle and range sheep is greatest. The inference which this correlation serves to emphasize is that deciduous fruit, specialty crops, truck crops, or beef cattle are each produced by growers whose main interests are in one or the other of those particular enterprises. In other words, it is a further demonstration of the existence of a high degree of specialization in individual farm organization in the state.

The dispersion of these various farm types and their marked tendency toward concentration in widely separated areas emphasize the second major characteristic of California agriculture, namely, the complexity and discontinuous nature of the agricultural pattern. Alfalfa-dairy combinations occur in large numbers in the Sacramento Valley and 500 miles or more south in the Imperial Valley. Truck farms predominate in the lower Salinas Valley, in the Santa Maria Valley, and in parts of the southern coastal plain. While differing materially in structure and perhaps in operations when viewed on any fine scale, their classification on the basis used or upon any other gross classification would depict the same discontinuous nature of the farm pattern.

The third and final dominant characteristic of California agriculture —namely, its capitalistic nature—could only be emphasized further through the use of accounting data of investment and capital value per unit, cash operating outlays or out-of-pocket expenses, and labor and power requirements as indicated by typical calendars of operation. Such presentation is beyond the scope of the present publication.

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APPENDIX A

CALIFORNIA COMMERCIAL FARM PRODUCTS

The basis of classification is that of differentiated types of commodities which are regularly produced and marketed. Varietal differences in crops and breed distinctions in livestock are not taken into account; by-products, as such, are not listed. The compilation is not warranted as entirely complete or free from some duplication. It aims to identify important types or lines of production as indicated by regularly recognized marketable products. On this basis there are listed 35 field crops, 68 fruits, 86 types of truck crops, 59 livestock products, and miscellaneous seeds, plants, and nursery products.

Field Crops

Barley
Beans (dried)
Broom corn
Corn (maize)
Cotton
Cowpeas
Flax
Grain sorghums
Hay crops
  Alfalfa
  Clover
  Grain
  Grain and legumes
  Tame grasses*
  Wild grasses
Hops
Medicinal crops
Millet
Oats
Pasture crops
  Alfalfa
  Tame grasses*
  Wild grasses
Peanuts
Peas (field)
Ramie
Rice
Rye
Safflower
Sesame
Silage crops (maize, sweet sorghums)
Soybeans
Stock beets
Sugar beets
Sunflowers
Tobacco (for nicotine)
Wheat

Subtropical Fruits

Citrus
  Grapefruit (pomelo)
  Lemon
  Lime
  Mandarin
  Orange
  Tangelo
  Tangerine
Other subtropical
  Avocado
  Carob
  Cherimoya
  Citron
  Date
  Feijoa
  Guava
  Jujube
  Loquat
Mango
Natal plum
Olive
Papaya
Passion fruit
Pepino
Persimmon
Pomegranate
Prickly pear (cactus)
Sapote

* Mixtures of Bermuda, Dallis, Harding, ryegrass, and others with and without legumes.

Deciduous-Tree Fruits

Apple
  Dried
  Fresh
  Processing (canning, cider, vinegar)
Apricot
  Canning
  Dried
  Fresh
Cherry
  Barreled
  Canning
  Fresh
Fig
  Canning
  Dried
  Fresh
Nectarine
  Canning
  Dried
  Fresh
Peach
  Canning
  Dried
  Fresh
Pear
  Canning
  Dried
  Fresh
Plum
  Canning
  Fresh
Prune
Quince

Grapes

Raisin
Table
Wine

Nuts

Almond
Chestnut
Filbert
Pecan
Pistachio
Walnut
  English (Persian)
  Black

Small Fruits

Backberries* and dewberries
Blueberry
Currant
Gooseberry
Huckleberry
Raspberry
Strawberry

Truck Crops

Artichokes, globe
Asparagus
  Canning
  Table
Beans (string, or snap)
Garden beets
Broccoli, sprouting
Broccoli, heading (cauliflower broccoli)
Brussels sprouts
Cabbage
Cantaloupes (muskmelons)
Cardoon
Carrots
Cauliflower
Celeriac (celery root)
Celery
Chard, Swiss
Chayote
Chervil
Chicory root (dried)
Chinese cabbage
Chives
Collard
Cress
Cucumbers
  Pickles
  Table
Daikon (Japanese radish)
Dandelion
Eggplant
Endive
French endive (chicory, green)
Garlic
Gourds
Herbs (aromatic, medicinal, and pot herbs)
Horse bean (faba bean, or broad bean)
Horse-radish
Jerusalem artichoke
Kale (borecole)
Kohlrabi

* Includes Boysen, Logan, Phenomenal, Young, and other varieties sometimes considered as separate products.

Truck Crops—*Continued*

Leek
Lentils
Lima beans
  Canning
  Dried
  Table
Mushrooms
Lettuce
  Head
  Leaf
  Romaine
Melons
  Casaba
  Honey Ball
  Honeydew
  Jap
  Persian
  Santa Claus
New Zealand spinach
Okra
Onions
  Green
  Dry
Oriental greens
Parsley
Parsnips
Peas
Peppers, bell
Peppers, chili
  Canning
  Dried
Pimiento (canning)
Potatoes
Pumpkins
Radish
Rhubarb
Roquette (rocket salad)
Roselle
Rutabaga
Salsify
Shallot
Spinach
  Canning
  Table
Squash
Sweet anise (Florence fennel)
Sweet corn
Sweet potatoes
Taro (dasheen)
Tomatoes
  Canning
  Table
Turnips
Watermelons
Zucca gourd, or melon

Seeds, Plants, and Nursery Products

Seeds
  Alfalfa
  Asparagus
  Clover
  Fenugreek
  Flower
  Grass
  Melon
  Mustard
  Sudan grass
  Sugar beet
  Vegetable
  Vetch
Plants
  Asparagus crowns
  Artichoke shoots
  Bedding plants
  Cut flowers
  Date shoots
  Fruit stocks
  Ornamental bulbs, corms, and tubers
  Ornamental shrubs and trees
  Strawberry plants
  Sweet-potato plants
  Tomato plants

Beef Cattle

Slaughter cattle
  Grass fats
  Fed stock (mature)
Stockers and feeders
Breeding stock (pure-bred and grade)

Dairy Cattle

Market cream
Manufacturing cream
Market milk
Manufacturing milk
Dairy cows and heifers
Breeding stock (pure-bred and grade)

Goats

Milk	Mohair	Breeding stock (purebred and grade)

Horses and Mules

Farm bred (common)	Purebred	
Work horses	Draft breeding stock	
Stock horses	Racing horses	
Pleasure horses*	Pleasure horses*	
Mules		
Asses and burros		

Poultry

Chickens	Geese	Turkeys
Market eggs	Guinea fowl	Market birds
Hatching eggs	Pigeons	Hatching eggs
Meat birds	Breeding pairs (commercial)	Breeding stock
Day-old chicks	Carriers and fancy stock	Day-old poults
Breeding stock		
Laying stocks		
Ducks	Squabs	

Rabbits

Meat	Breeding stock	Fur

Sheep

Slaughter stock	Wool	
Lambs	Breeding stock (purebred and grade)	
Sheep		
Feeder lambs		

Swine

Market hogs	Feeder pigs	Breeding stock (purebred and grade)

Miscellaneous Livestock

Bees	Dogs	Laboratory (experimental) stock (Guinea pigs, mice, rats)
Honey	Stock dogs	
Package bees	Show and pets	
Queen bees	Fish (ornamental, and market types)	
Beeswax	Fur-bearing animals (chinchilla, fox, muskrat, skunk)	
Domestic game birds (chukors, doves, ducks, peafowl, pheasants, quail, red junglefowl)	Pelts	
	Breeding stock	

* Includes saddle, trail, polo, and fancy show stock.

APPENDIX B
BASIC TABLES

TABLE 2

Types of Irrigated Crops by Regions in California in Acres and Percentage of Total Harvested Acreage, 1929*

Region	Total irrigated crops†	Small grains and hay	Large grains	Alfalfa	Small row crops	Rice	Cotton	Grapes	Deciduous fruit	Subtropical fruit	Miscellaneous
	Thousands of acres										
State	3,589.8	623.1	118.1	719.6	562.4	80.7	292.7	413.8	527.4	251.1	0.9
North coast	11.9	0.8	0.3	4.6	0.9	0.0	0.0	0.7	4.6	0.0	0.0
Central coast	255.5	10.8	0.8	44.9	106.1	0.0	0.0	4.6	88.3	0.0	0.0
South coast	565.3	25.2	8.4	50.9	151.5	0.0	0.0	20.7	113.2	195.0	0.4
Mountain	200.5	137.0	0.5	53.2	1.1	0.0	0.0	0.3	8.4	0.0	0.0
Sacramento Valley‡	501.2	60.8	29.1	79.4	91.8	67.4	2.2	27.6	138.1	4.7	0.1
San Joaquin Valley	1,676.2	317.2	56.2	340.0	136.0	13.2	248.4	355.3	170.5	39.2	0.2
Colorado-Mojave Desert	379.2	71.3	22.8	146.6	75.0	0.1	42.1	4.6	4.3	12.2	0.2
	Per cent of harvested acreage										
State	53.9	9.4	1.8	10.8	8.4	1.2	4.4	6.2	7.9	3.8	0.0
North coast	3.5	0.2	0.1	1.4	0.2	0.0	0.0	0.2	1.4	0.0	0.0
Central coast	26.8	1.1	0.1	4.7	11.1	0.0	0.0	0.5	9.3	0.0	0.0
South coast	62.1	2.8	0.9	5.6	16.6	0.0	0.0	2.3	12.4	21.4	0.1
Mountain	57.3	39.2	0.1	15.2	0.3	0.0	0.0	0.1	2.4	0.0	0.0
Sacramento Valley	35.2	4.3	2.0	5.6	6.5	4.7	0.2	1.9	9.7	0.3	0.0
San Joaquin Valley	73.4	13.9	2.4	14.9	5.9	0.6	10.9	15.6	7.5	1.7	0.0
Colorado-Mojave Desert	94.3	17.7	5.7	36.4	18.7	0.0	10.5	1.1	1.1	3.0	0.1

* Total harvested acreage by regions given in table 3, col. 4.

† Sum of area planted includes interplanted and double-cropped but does not include acreage in greenhouses, flowers, and home gardens.

‡ Includes minor acreages in the mountain region lying in Shasta, Placer, and Nevada counties.

Source of data:

United States Bureau of the Census. Fifteenth Census of the United States, 1930. Irrigation of agricultural lands. p. 93–98, 348–77. 1932.

TABLE 3

LAND AREA, CROPLAND, AND TYPES OF CROPS IN ACRES AND PERCENTAGE OF HARVESTED ACREAGE BY REGIONS IN CALIFORNIA, 1929

Region	Land area	Cropland			Area planted in									
		Total	Failure, idle, or fallow	Harvested	Small grains and hay	Large grains	Alfalfa	Small row crops	Rice	Cotton	Grapes	Deciduous fruit	Subtropical fruit	Miscellaneous
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*
	Thousands of acres (i.e., 000 omitted)													
State	99,619*	8,391	1,839	6,661	2,909	162	794	785	82	300	531	832	255	11
North coast	7,852	380	45	340	160	8	17	12	0	0	43	98	0	2
Central coast	9,059	1,159	242	952	462	8	55	210	0	0	21	188	0	8
South coast	7,550	1,096	193	911	258	14	57	217	0	0	37	130	197	1
Mountain	20,511	475	120	350	259	2	73	2	0	0	2	12	0	0
Sacramento Valley	11,137	1,883	463	1,422	846	31	94	119	69	5	44	208	6	0
San Joaquin Valley	15,833	2,914	670	2,283	835	75	349	150	13	252	379	190	40	0
Colorado-Mojave Desert	27,677	484	106	403	89	24	149	75	0	43	5	6	12	0
	Per cent of land area				Per cent of harvested acreage									
State	100	8.4	1.8	6.7	43.7	2.4	11.9	11.8	1.2	4.5	8.0	12.5	3.8	0.2
North coast	100	4.8	0.0	4.3	47.1	2.4	5.0	3.5	0.0	0.0	12.6	28.8	0.0	0.6
Central coast	100	12.8	2.7	10.5	48.6	0.8	5.8	22.1	0.0	0.0	2.2	19.7	0.0	0.8
South coast	100	14.5	2.6	12.1	28.3	1.5	6.3	23.8	0.0	0.0	4.1	14.3	21.6	0.1
Mountain	100	2.3	0.6	1.7	74.0	0.6	20.8	0.6	0.0	0.0	0.6	3.4	0.0	0.0
Sacramento Valley	100	16.9	4.2	12.8	59.5	2.2	6.6	8.4	4.9	0.3	3.1	14.6	0.4	0.0
San Joaquin Valley	100	18.4	4.2	14.4	36.6	3.3	15.3	6.6	0.6	11.0	16.6	8.3	1.7	0.0
Colorado-Mojave Desert	100	1.7	0.4	1.5	22.0	6.0	37.0	18.6	0.0	10.7	1.2	1.5	3.0	0.0

* According to a remeasurement given in the 1940 Census the total land area is 100,353,920 acres.

Source of data: United States Bureau of the Census, Fifteenth Census of the United States, 1930. Agriculture. The Western States. 2(3):518–22, 538–66. 1932.

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